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Abstracts of Principal Articles

The Production of Components for Lambretta Motor Scooters.....P. 584

In this, the last of a series of articles describing typical operations at the Innocenti factory, the design of the recently-introduced Lambretta TV175 motor scooter and its engine unit are first briefly discussed. Machining operations on the pressure die cast crankcase, and its associated cover casting, are then described. After the joint face has been rough- and finish-milled, the crankcase is transferred to a fine-boring machine, on which the rear axle housing is bored, and two circlip grooves are cut. The castings are then passed to a 4-way drilling machine on which most of the holes for studs and screws are drilled, and then to a tapping machine, of similar type. For drilling and tapping holes in faces at 10 deg. to one another, auxiliary spindles are employed, one of which is driven through a universally-jointed shaft. After further boring operations, the crankcase and the cover castings are brought together, so that certain bores in the two components may be machined at one setting. At the same time, dowel bush holes are machined to ensure accurate relative location on assembly. Various bores in the cover casting are then machined, and other holes are drilled, spot-faced and tapped. (MACHINERY, 92—14/3/58.)

Marbaix Special-purpose Rotary Transfer Machine .....P. 598

The special machine described in this article is designed to perform a series of operations on a fuel pump component in a cycle time of 46 secs. A pawl and wedge arrangement provides for both indexing and location, and ensures an accuracy of $\pm 0{\cdot}0015$ in., with an indexing period of 3 sec. There are two special heads for milling curved slots in the face of the component, and each head incorporates a cam with a helical groove, whereby the required planetary motion is imparted, and end surfaces for feeding the cutter to depth and retracting it. Unit drill heads and air-operated tapping units are employed for other operations on the component. After a part has been unloaded from the indexing table, it is placed in a fixture at one side of the loading position. Here, an impact air cylinder is employed to mark two characters on one face, while drilled holes are deburred by a multi-spindle head. (MACHINERY, 92—14/3/58.)

Four-spindle Boring Machine with Punched Tape Control ..... P. 603

Intended for operations on ring-type components such as compressor casings for jet propulsion units, the boring machine here described has a rotary work table arranged for numerically controlled indexing to a positional tolerance of 0·005 in. at 50 in. diameter. The boring head has four spindles with their axes in the same vertical plane and is moved vertically, under numerical control, to bring any spindle to a required working height. In addition, the paper tape determines the speed of the selected spindle, the feed rate, and the depth of cut. As many as four operations can be performed on any particular hole. (MACHINERY, 92—14/3/58.)

Special Point Form for Twist Drills...P. 605

The Cincinnati Lathe & Tool Co., U.S.A., have developed a special point form for twist drills, characterized by the fact that the point angle blends with a small radius, near the axis, so that a central projection is formed. It is claimed that this Spiropoint drill, as it is termed, has a self-centring action which facilitates accurate hole location without the use of guide bushes or centre-punch marks. In addition, it is stated that an improved cutting action is obtained, and that the axial load on the drill can be substantially reduced. A special machine for grinding drills with this point form is also described. (MACHINERY, 92—14/3/58.)

Special Stretching Equipment for Large Wing-skin Panels ..... P. 607

Certain large wing-skin panels for DC-8 jet-propelled air liners are subjected to a stretching operation over the area where the portion with dihedral and sweepback blends with the root portion. The panels in question are cut from taper-rolled sheets which measure 46 by 10 ft. After a preliminary bending operation, each panel is transferred to a special stretching press, said to have been designed, constructed and installed in a period of 140 days. This press has a large die table, which can be raised and lowered by a 450-ton hydraulic ram. Two pads, each of which is operated by two 600-ton rams, serve to clamp the sheet at the edges of the area to be stretched, so that the action is localized. The stetching force is exerted by eight hydraulic cylinders, each of 150 tons capacity. There are four cylinders at each end of the press, and the rams of two cylinders are connected to each gripping jaw by a clevis. (MACHINERY, 92—14/3/58.)

Modern Presswork Techniques ... P. 610

In this second article, based on a paper presented by Mr. T. G. Woodward at a recent conference organized by the Institute of Sheet Metal Engineering, the production of pressings on in-line and rotary transfer presses is considered. Operations and tooling for the manufacture of a pressing for a motor-car rear-number-plate lamp on an in-line press are described, and details are given of some interesting tools for drawing and side-piercing. The production of a lampholder on a rotary transfer press is discussed, and the operation sequence includes drawing and side-piercing, also rolling and trimming with motor-driven attachments. (MACHINERY, 92—14/3/58.)

Recruitment of Science and Technology Teachers

One of the major difficulties with which British industry has had to contend in its struggle for recovery since the war has been the shortage, in all fields, of adequately-trained technologists. Although magnificent work has been done in certain directions—notably in connection with the application of atomic power and the development of gas turbines—the available technological and scientific manpower resources have been spread so thinly, in most branches of industry, that the development and application of improved techniques and equipment have often proceeded at an inordinately slow pace, and research, on which our future prosperity must depend, has been dangerously restricted. Our position as an exporting nation has been rendered even more grave by the efforts that have been made to train large numbers of scientists, technologists, and engineers in the U.S.A. and Russia, which are now coming to fruition. Attention was drawn once more to the parlous condition of our technical education facilities by Lord Hives when he presented the 1957 Viscount Nuffield paper of the Institution of Production Engineers, and he emphasized that our present difficulties are due principally to neglect of those facilities during the past 10 to 15 years.

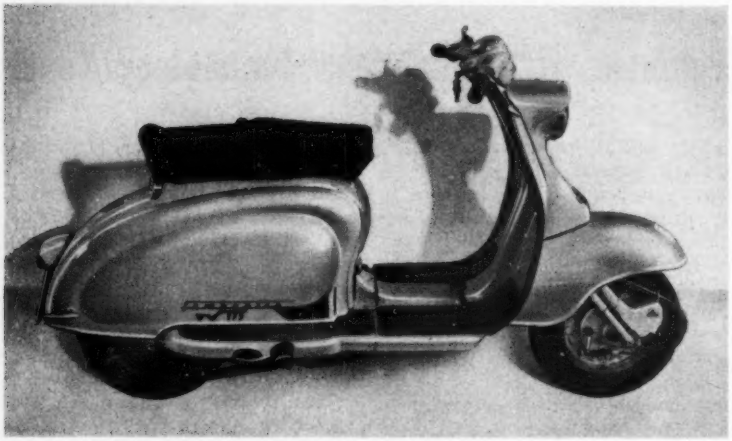
The formation of the National Council for Technological Awards, with Lord Hives as chairman, and the introduction of the Diploma of Technology examinations, were welcomed as indications that the Government had become aware of the dangers inherent in the inadequacy of our provisions for technological education, and the setting up of the Jackson Committee to investigate the supply and training of teachers for technical colleges was regarded as further evidence that the authorities were making a real, if somewhat belated, effort to remedy the situation.

A report on the findings of the Jackson Committee was published in May, 1957, and its more important points were underlined in a circular which was sent recently by the Minister of Education to local education authorities and governors of technical colleges. The committee expressed the view that 7,000 more full-time, and 8,000 part-time teachers would be required by 1960-1961. According to the Ministry, 1,400 new science and specialist teachers should be recruited this year, and this figure represents increases of 40 and 50 per cent on the intakes for 1957 and 1956, respectively.

No one would seriously dispute that increases of this magnitude in our teaching forces are essential, but considerable difficulties are likely to be encountered in the recruitment of the necessary trained scientists, technologists, and engineers, in view of the pressing demands of industry. Little enlightenment on how the required numbers of new teachers are to be obtained is given in the Ministry circular, but it would appear that reliance is to be placed mainly on the implementation of certain recommendations of the Jackson Committee. Thus, it is hoped to make teaching in technical colleges more attractive to men and women—both new graduates and those already engaged in industry—by providing better amenities, and more clerical, laboratory and workshop assistance; by reducing excessive hours of teaching; by providing facilities for research in college laboratories; and by allowing teachers to undertake consultant work, so that they can maintain their contacts with industry. It is also recommended that teachers should be released in order to train for first and second degrees, or the Diploma of Technology; that they should be allowed to return to industry for short "refresher" periods; and that they should be given leave of absence to carry out special studies, or surveys, or to visit teaching establishments abroad.

If these recommendations are put into effect, they may well make teaching in technical colleges more attractive. It would appear, however, that most of them can only be implemented after teaching staffs have been substantially increased, and the urgency of the situation surely demands more positive remedies. Undoubtedly, there will always be a certain number of graduates who will be attracted to teaching from a sense of vocation. Their numbers are limited, however, and must be supplemented by others who would normally turn towards industrial careers, and those who may already be employed in industry or other fields. Such scientists and technologists are unlikely to consider that the proposed, rather nebulous, attractions counterbalance the greater financial rewards of industry, and if our scientific and technological training facilities are to be expanded, a revision of the salary scales for teachers in these fields—both full-time and part-time—should not be long delayed. As Lord Hives has pointed out in his paper "the recent successes of the Russian

(*Continued on page* 634)



The Production of Components for Lambretta Motor Scooters

Operations on Crankcase Castings for the New TV 175 Scooter

A series of articles recently published in MACHINERY* was concerned with the general organization of the Innocenti company, and their large factory in the Lambrate district of Milan, Italy. Details were given, in these articles, of the methods employed for the manufacture of components for the engine units fitted to the 125- and 150-c.c. motor scooters, which have now been in production for a number of years. Among the components considered, were pistons, air-cooled cylinders, connecting rods, and crankshaft components, and operations on crankshaft subassemblies were also described. During last year a new motor scooter, known as the TV 175, from the fact that it incorporates a 170-c.c. capacity engine, and intended more for sports use, was introduced in Italy, and it has now been announced that this scooter is to be made available in this country shortly. The new scooter is shown in the heading illustration, and it is powered by an engine of entirely new design, some features of which are shown by the horizontal section, Fig. 1.

In the new engine, which has a bore and stroke of 60 m.m. (2·362 in.), and a capacity of 170 c.c., the cylinder has been transferred from the position on top of the crankcase, occupied in previous designs, to the front face, and has a slight downward inclination. The greatest change, however, is in the design of the crankcase, which is now made in the form of a one-piece pressure die casting in aluminium, instead of in several parts, as before. Consequently, the difficulties associated with the machining of the various castings, and securing them together with sufficient accuracy, have been overcome. The gearbox is now incorporated in the crankcase, and the whole assembly presents a neater appearance. This crankcase is one of the largest pressure die castings now being made in Italy, and machining operations on both the main casting and the cover, which is secured in position by studs and nuts, are described in this article. First, however, brief reference will be made to some of the design features of the engine and transmission unit.

Most of the engine components are generally similar to those described in connection with the smaller units, but of somewhat heavier proportions. The left-hand end of the crankshaft, as viewed from the rear, carries the cooling fan, whereby air is drawn in and circulated round the fins of the cylinder and head, also the magneto flywheel assembly. Splined to the other end of the shaft is a bell-housing for the multi-disc clutch, through which the drive is transmitted to a double roller

* MACHINERY, 92/60–10/1/58, 92/176–24/1/58, 92/292–7/2/58 and 92/468–28/2/58.

chain sprocket. The separate shaft whereon the clutch and sprocket are mounted is supported on two ball bearings, housed in castings which are bolted in position in the main casting at the assembly stage. An approximately vertical bore in the cover casting receives the shaft through which pressure is transmitted to operate the clutch. From the clutch sprocket, the drive is transmitted by a double roller chain to a larger sprocket, mounted on needle roller bearings on a transverse shaft towards the rear of the crankcase.

This shaft is supported at the outer end in a bore in the crankcase cover casting, and at its inner end in an iron casting A, which is dowel-located and held in place in the main casting by studs and nuts. The sprocket incorporates a safety clutch for protection of the mechanism, and a spur gear whereby the drive is transmitted to the idler shaft of the gearbox, which carries a 4-step spur gear. In constant mesh with the teeth of this 4-step gear, there are four separate driving gears on the rear axle of the unit, any one of which can be coupled to the axle by a sliding key on a shaft connected to the gear lever. Both the idler shaft and the rear axle are housed partly in the crankcase and partly in the iron casting A, on ball and needle roller bearings. The surface of the crankcase adjacent to the combined brake drum and wheel hub casting has integral bosses to carry the brake shoes, and the camshaft

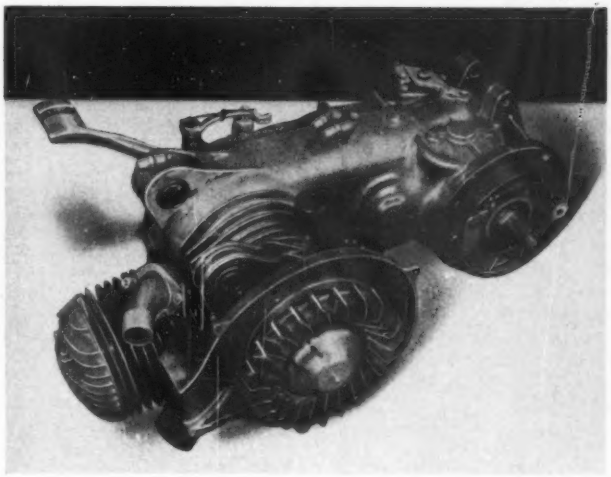


Fig. 2. View of an Assembled Engine and Transmission Unit for the TV 175 Scooter, Showing the Induction Pipe, the Cooling Fan Inside Its Die Cast Shroud, and the Shoes for the Drum Brake at the Right

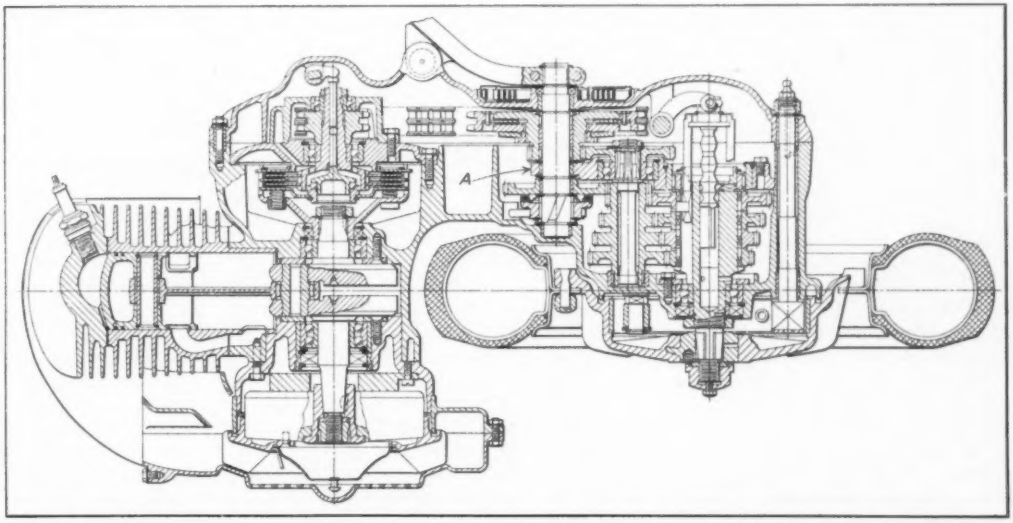


Fig. 1. Sectional View of the Engine and Transmission Unit for the New Lambretta TV 175 Motor Scooter, Showing the Arrangement of the Multi-disc Clutch and the 4-speed Gearbox

whereby they are expanded. Some of these details can also be seen in the illustration of the completely assembled unit in Fig. 2, also the integral lugs, fitted with Silentbloc rubber suspension bushes, for the attachment of the unit to the scooter frame.

The engine develops a maximum of 9 h.p., and is capable of propelling the scooter, which has an unladen weight of 242 lb., at a maximum speed of 65 m.p.h. Under normal conditions, approximately 94 miles can be covered on one gallon of fuel. In addition to the crankcase, the scooter incorporates several other aluminium pressure die castings notably for the handlebars, and for the shroud which covers the frame above the front wheel and incorporates the headlamp housing. We hope to describe the production of some of these castings, which are made by an outside supplier, in a future die-casting supplement.

OPERATIONS ON CRANKCASE CASTINGS

Views showing the shape and some of the principal dimensions of the crankcase casting are included in Fig. 3, from which it will be seen that it is of thin-walled construction, incorporating a number of internal stiffening ribs. From an examination of other illustrations—notably Fig. 9—it will be apparent that the parting plane of the die in which the casting is produced is parallel to the cover face. The internal ribbed surfaces are produced by projections from the face of the fixed half of the die. Outside surfaces, including the cooling and stiffening ribs that partially surround the boss to which the cylinder is secured, and pass along the lower side of the case, are formed by four interlocking core blocks arranged approximately at 90 deg. to each other, in box formation. Projections from one of these cores form the inside and outside surfaces of the cored boss for the cylinder mounting face and spigot, which is set at an angle of 10 deg. to the longitudinal centre line of the casting. The various holes and pockets on the side of the casting remote from the cover face are cored by projections from the face of the moving die member. The casting is made in F480 aluminium alloy and has a trimmed weight of 15¼ lb.

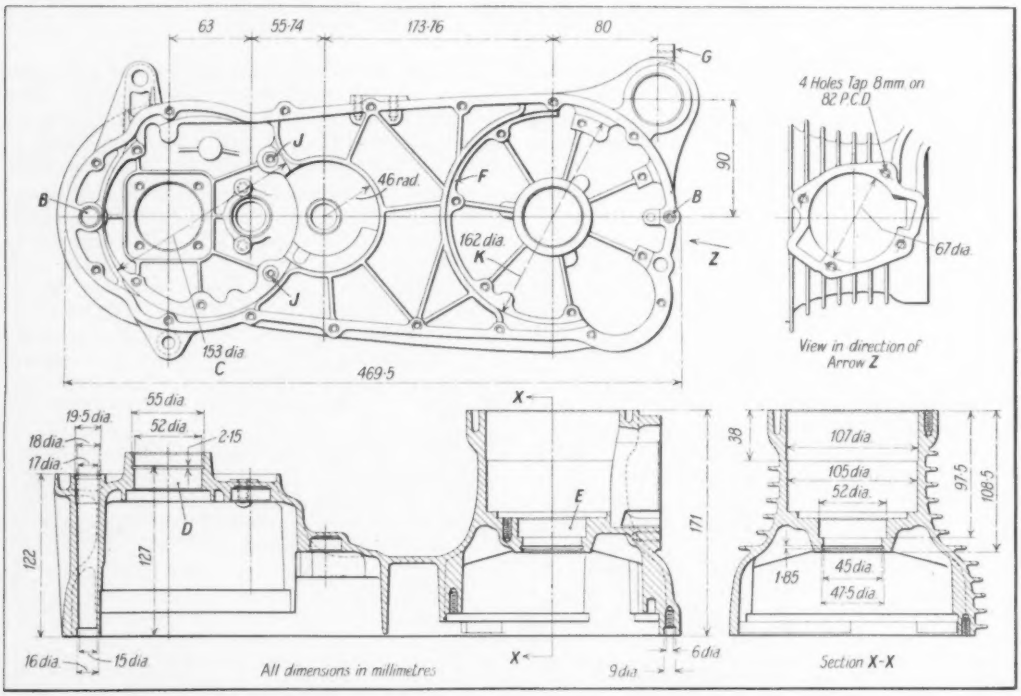


Fig. 3. Sectional Views of the Crankcase Casting for the TV 175 Motor Scooter Engine. The Bore *E* Accommodates the Ball Race for the Clutch End of the Crankshaft, and the Bore *D*, the Axle Ball Race

Before reaching the machine shop, the castings are subjected to a heat treatment designed to stabilise them dimensionally, and for this purpose they are held at a temperature between 180 and 200 deg. C., for a period of 6 hours. The castings are then delivered to the starting end of a line of machines on which they are finished complete, ready for assembly. A continuously - moving pendant type conveyor serves the machine line and transports the castings from one machine to another, and carries them away when the series of operations has been completed. The first operation on the casting provides for rough- and finish-milling the cover face, and is carried out on an Olivetti (British Olivetti, Ltd.), F.C. 4, 2-spindle vertical machine. Each spindle is fitted with a 250-mm. (9·842-in.), diameter cutter, with 10 inserted carbide-tipped blades, and is driven by a 10-h.p. motor. One of these cutters is employed for the roughing, and the other for the finishing operation, and the floor-to-floor time for this stage is 2 min.

Fig. 4. General View of the Cimatic 3UN2 Fine Boring Machine Employed for the First Boring Operations on the Crankcase, After the Cover Face has been Rough- and Finish-milled

CIMATIC FINE BORING MACHINE

From the milling machine, the castings are passed to the adjacent Cimatic 3 UN 2, fine boring machine shown in Fig. 4, on which various boring, facing and grooving operations are performed. This machine has a fixed central table on which the work fixture is mounted, and bed ways at each end to carry the spindle heads. A close-up view of the machine, showing details of the clamping arrangements, is given in Fig. 5, and it will be observed that the casting is loaded with the cover face in contact with one vertical wall of the L-shaped fixture. The casting is located, in this and most of the other fixtures on the machining line, by means of two holes, one at each end, which are indicated at *B* in Fig. 3. These two holes are drilled at the foundry, and the smaller, which has a finished diameter of 9 mm. (0·354 in.), is employed, in the final assembly, for the location of the cover casting by means of a tubular dowel, through which a securing stud passes. The other, larger hole has a finished diameter, at the cover face end, of 16 mm. (0·629 in.), and it accommodates the brake camshaft.

Three hydraulically-operated clamps of generally similar design are provided, two below and one above the casting. The rams of the clamping cylinders extend on the side of the fixture buttress whereon the casting is located, and they carry clamping fingers, which are turned slightly as the rams are drawn in to apply the clamping pressure. These clamps are operated by means of the valve at the lower right-hand side in Fig. 5, and, as they are retracted, the fingers are moved aside so that they do not interfere with the unloading operation. On the head at the left in Fig. 4 there is only one spindle, which is equipped with a combined boring and facing unit. The boring tool is held in a fixed position, and is employed to machine the incomplete bore *C*, Fig. 3, to a diameter of $153+0{\cdot}04-0$ mm. ($6{\cdot}024+0{\cdot}0016-0$ in.). When this tool has reached its full depth, the head dwells while the facing slide is fed sideways to finish the face to which the iron casting *A*, Fig. 1, is subsequently secured by studs and nuts. These operations are carried out at a spindle speed of 420 r.p.m. and a feed rate of 0·1 mm. (0·004 in.) per rev. At the end of the facing operation, the

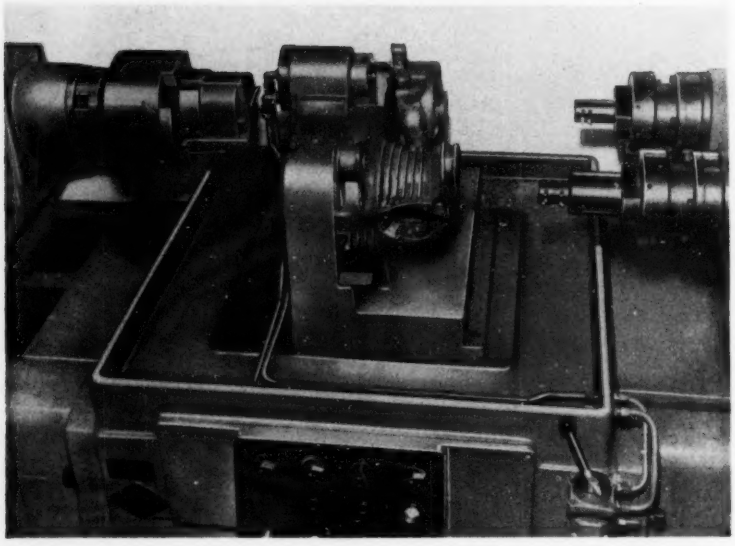


Fig. 5. Close-up View of the Tooling Area on the Machine in Fig. 4. One of the Hydraulic Clamping Cylinders May be Seen at the Top of the Fixture. The Spindles at the Right are Employed for Plunge Forming the Circlip Grooves in the Crankshaft and Rear Axle Bores

spindle is stopped while the facing slide is withdrawn. The head then moves back to the position shown.

There are two spindles on the head at the right in Fig. 4, which are employed to plunge-form two circlip grooves, in the bores *D* and *E* Fig. 3, and to chamfer the ends of these bores. The rear spindle has two tools and operates on the bore *D*, only the end that is facing the spindle being chamfered. Three tools are fitted to the front spindle to chamfer both ends of the bore *E* in addition to cutting the circlip groove. The spindle head is fed to a stop, and the facing slides are then moved outwards for the grooving and chamfering operations, which are performed at a spindle speed of 1,010 r.p.m. Grooving tools, 2·15 and 1·85 mm. (0·0846 and 0·0729 in.) wide, are fed to depths of approximately 1·5 and 1·25 mm. (0·059 and 0·049 in.) in the bores *D* and *E*, respectively. After the tools have been fed to depth, the spindles are stopped before the facing slides are retracted, and the head is then withdrawn to the right. These machining operations are carried out simultaneously in a completely automatic cycle, which is initiated by pressing one of the buttons on the panel in front

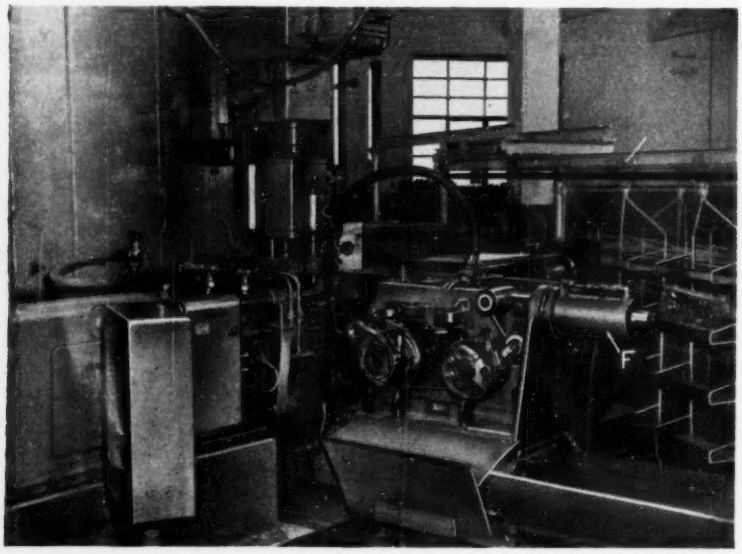


Fig. 6. On this Special Oerlikon-Italiana Machine the Casting is Loaded on a Travelling Fixture which is then Moved to the Drilling Position at the Left. A Total of 52 Holes is Drilled on this Machine

of the fixture. The cycle occupies about 1 min. and the floor-to-floor time for the operation is 2 min.

OERLIKON MULTI-SPINDLE DRILLING MACHINE

From the fine borer, the castings pass to the Oerlikon-Italiana (Vaughan Associates, Ltd.) multi-spindle drilling machine shown in Fig. 6, on the conveyor which is just visible in the background. This machine has four drill heads with a total of 52 spindles, for drilling all the holes for fixing studs, also a number of other holes in various positions in the casting. For convenience in loading, the fixture is mounted on guideways, on which it is moved by a long-stroke hydraulic cylinder from the loading to the drilling position, where it is held in contact with a fixed stop. The fixture has a vertical face, on which the casting is located by the same two dowel holes as before. There are four clamps, two at the top and two beneath the casting, and provision is made for turning the upper pair slightly, so that their fingers project over the surface of the casting surfaces, by means of the cylinder *F*. The fingers are attached to the rams of smaller hydraulic cylinders in the vertical wall of the fixture casting, and these rams, in turn, are operated to pull the fingers inwards, so that the casting is clamped.

The lower edge of the casting is clamped by means of two swivelling, wedge-shaped fingers, mounted on a shaft housed in a bore at the base of the fixture wall. Beneath each finger there is a hydraulic cylinder, with its axis vertical, and when a hydraulic valve on the machine bed is operated, the rams of these cylinders are raised, to turn the fingers about the shaft and press them into contact with the lower edge of the casting. The right-hand head, beyond the fixture in Fig. 6, has 31 spindles, for drilling holes for various studs in the cover face and the interior of the casting. There are 16 holes, for tapping 6mm. (0·236 in.), in the cover face, for the studs whereby the cover is held in place, and five holes, for tapping 7 mm. (0·275 in.), in the face machined on the fine borer at the previous stage, for studs which hold the casting *A*, Fig. 1, in place. Two of these holes have stepped diameters, as will be explained later. In the same portion of the casting, four holes are drilled for 6-mm. bolts, which secure the retaining plate for the axle ball race. In addition, seven holes for 6-mm. bolts are drilled in the face *F*, Fig. 3, for securing the casting in which the double roller chain sprocket and clutch shaft are carried.

The left-hand head of the machine operates on the outside of the casting, seen facing the camera in Fig. 6, and is equipped with a total of 11 drills. Of these, six are employed to drill holes, for tapping 5 mm. (0·197 in.) in the face of the housing for the crankshaft, at the left in Fig. 6. Studs, which are later fitted in these holes, are employed to secure the casting carrying the bearings for the flywheel end of the crankshaft. Three holes, for tapping 5 mm., are also drilled in a face within the crankshaft housing, surrounding the bore *E* Fig. 3, for screws which secure a retaining ring for one of the crankshaft ball races. The two other spindles carry combined drills and spot-facing tools, which are applied to the mounting bosses for the brake shoes in the housing at the right-hand end of the casting in Fig. 6, the drilled holes being subsequently tapped 8 mm. (0·315 in.).

In the vertical head, above the fixture, there are three spindles, one of which carries a combined drill and spot-facing tool for operations on a circular boss on one side of the housing for the flywheel end of the crankshaft. This boss, which is drilled 12 mm. (0·472 in.) diameter, is later fitted with a rubber bump stop which forms part of the spring suspension of the unit, the stop being clearly seen in Fig. 2. The other two spindles are employed to drill holes, for 6 mm. screws, in a triangular boss on top of the casting at the centre, for mounting a plate which forms part of the scooter

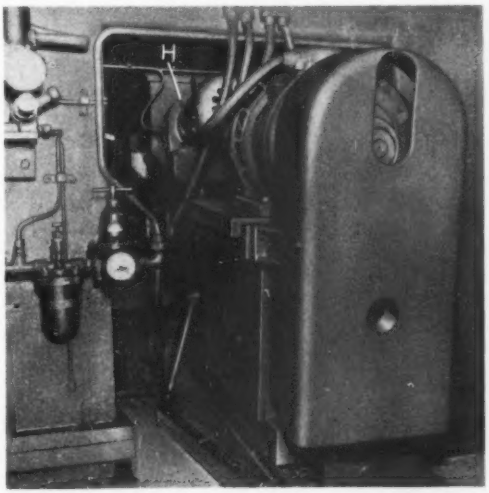


Fig. 7. Four Tapping Holes for the Cylinder Holding-down Studs are Drilled at an Angle of 10 deg. to the Longitudinal Centre Line of the Casting by this Large Head which is Mounted Beneath the Vertical Column of the Machine in Fig. 6. The Head *H* Drills a Separate Hole

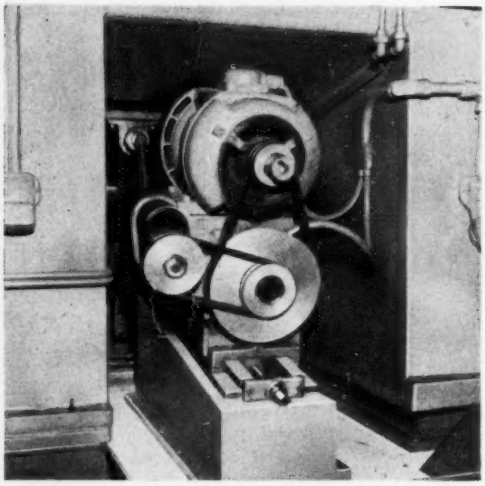


Fig. 8. For Tapping the Holes Drilled by the Heads in Fig. 7, on a Similar Machine to that Shown in Fig. 6, Two Heads are Again Employed

controls. The fourth head on this machine is housed within the base of the column which supports the vertical head, and is employed to drill four holes, for tapping 8 mm. (0·315 in.), to receive the studs whereby the cylinder and head are secured to the crankcase. Since the axis of the cylinder is inclined at an angle of 10 deg., the guideways on which the head is mounted are similarly inclined, as seen in Fig. 7, which gives a close-up of the head from the rear of the machine. In addition to the four stud holes, a hole is required in a lug *G*, Fig. 3, for a cable adjuster, and this is drilled, for tapping 9 mm. (0·354 in.), by a small single-spindle head secured to a horizontal flat surface on the underside of the column bridge at *H*, Fig. 7.

From the drilling machine the castings pass to another Oerlikon-Italiana machine of similar construction, designed to tap the various holes drilled on the first machine. The casting is accommodated in a moving fixture, of the same design as before, and the heads are arranged for tapping under lead-screw control. Only one hole, for the rubber bump stop, is not tapped on this machine. For tapping the four cylinder stud holes, and the larger hole for the cable adjuster, a unit head is fitted in the same position as before, as shown in Fig. 8. This head is equipped with four taps and is arranged for spindle reversal when the taps have reached full depth. The larger, horizontal hole, in the lug *G* Fig. 3, is tapped by a lead-screw controlled spindle, in a housing secured to a flat

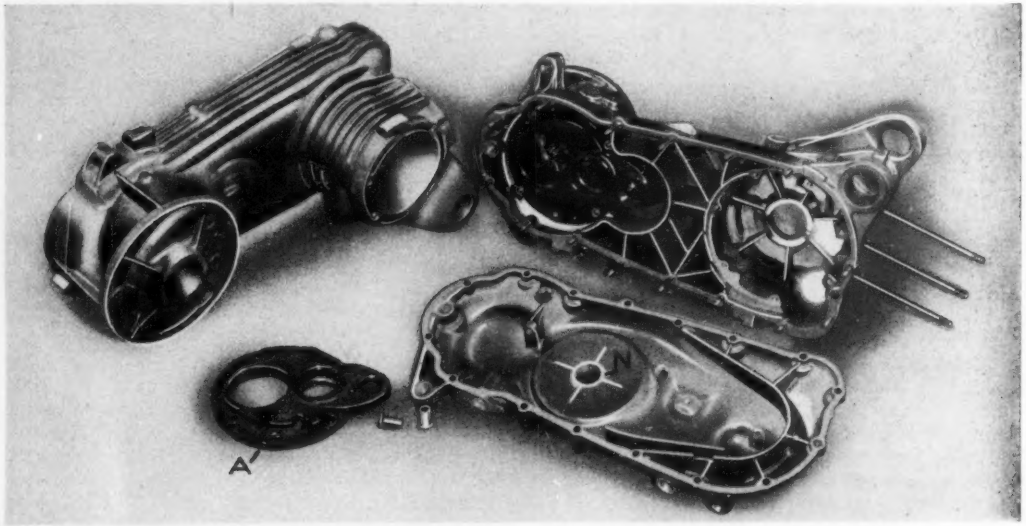


Fig. 9. Views of an Unmachined Casting (left), a Completed Casting Fitted with Studs (right), and a Machined Cover Casting. The Iron Casting *A* is Assembled to the Crankcase Before Final Boring Operations are Carried Out

face on the under-side of the column bridge. This spindle is driven through V-belts, a small gearbox, and a universally-jointed shaft, from the pulley shaft of the unit head.

After being unloaded from the fixture of the tapping machine, the castings are again placed on the pendant type conveyor, on which they are transported to a fitting bench. Here the castings are held at a convenient angle in a simple fixture, without being clamped, while three 7-mm. (0·275 in.) diameter studs are inserted with the aid of a Desoutter air-operated stud-runner. A view showing an unmachined casting, on the left, with one of the iron castings, indicated at *A* in Fig. 1, which support the ends of the gearbox and axle shafts in the final assembly, is given in Fig. 9. Here the iron casting is again denoted by the letter *A*. This casting is now fitted into position, as seen in the finished crankcase at the upper right, so that its bearing bores, which have already been semi-finished elsewhere, may be accurately finish-bored together with the associated bores in the main casting. In the final assembly, the casting *A* is accurately located by means of two hardened and ground steel dowels of hollow flanged design, as seen in the foreground in Fig. 9.

These dowels are passed through accurately-finished holes in the casting *A* into stepped portions of the two stud holes indicated at *J* in Fig. 3. Stepped drills on the machine in Fig. 6 are employed to produce the holes *J*, Fig. 3, to a diameter of 10·5 mm. (0·4134 in.), for a depth of 10 mm. (0·393 in.), and the threaded holes extend for a further 13 mm. (0·519 in.) beyond the step. A gauge, comprising a steel bar with two dowels to fit into the holes marked *B*, Fig. 3, and with projections to enter the bearing bores in the casting *A*, is now fitted to locate the latter. Three of the five nuts which secure the casting *A* are then fitted and tightened with a Desoutter nut runner, leaving the two holes *J* vacant. The gauge is then removed and the casting loaded into the fixture of the special machine shown in Fig. 10.

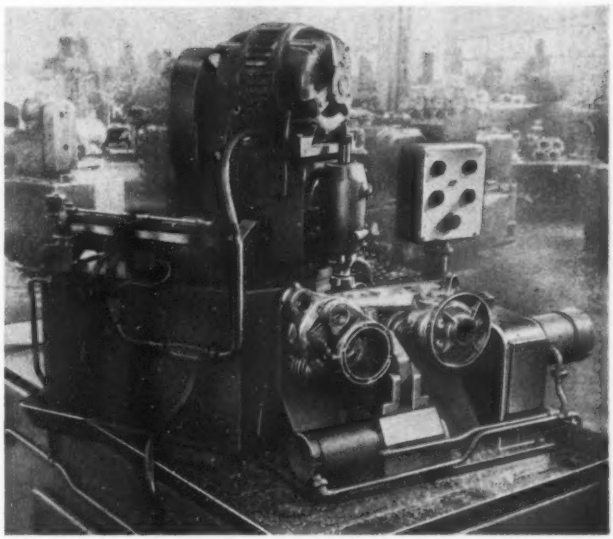


Fig. 10. Special Milling and Reaming Machine Employed for Facing a Boss on Top of the Casting, for a Control Cable Bracket, and Line-reaming Dowel Bush Location Holes in the Casting *A*, Fig. 9, and the Crankcase

SPECIAL MILLING AND REAMING MACHINE

This machine is designed to line ream the holes *J*, Fig. 3, and the corresponding holes in the casting *A*, before the finish-boring operations, mentioned above, are carried out. In addition, the machine has a milling head which faces the triangular boss on top of the casting. On the vertical face of the fixture the casting is again located by dowels in the cover face holes *B*, Fig. 3. By operation of a pneumatic valve at one side of the machine, air is then admitted to the rear of the piston in a horizontal cylinder at the left-hand end of the fixture casting. The ram of this cylinder is connected to a wedge, above which there is a vertical plunger. At the upper end, the plunger projects between two uprights, which support a swivelling lever with a horizontal and a vertical face. As the plunger rises, the lever is turned so that its vertical face is pressed against the outside of the casting, which is thus held securely in contact with the face of the fixture. At the same time, air is supplied to another cylinder, at the further end of the fixture. The ram of this cylinder has rack teeth which engage with a pinion on a vertical shaft. Above the fixture casting, the shaft carries a clamping finger, and, when the shaft is turned, the finger is swung round, so that it clamps the casting securely at the right-hand end.

At the left-hand side of the flat top surface of the machine base, there is a milling head with a vertical spindle, carrying a 3-bladed carbide-tipped facing cutter of 65 mm. (2·559 in.) diameter. This

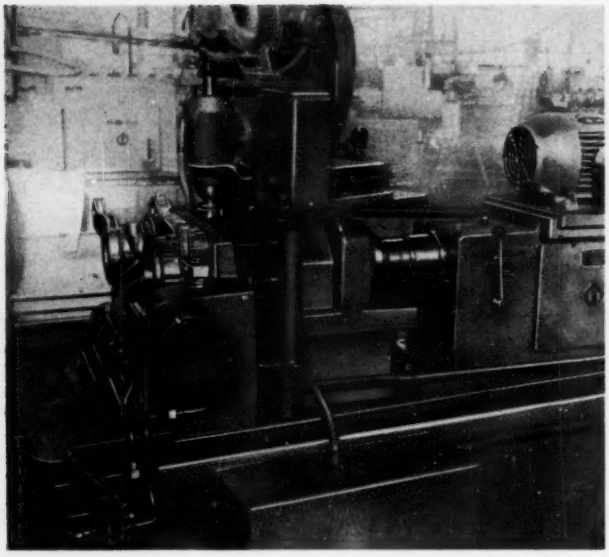


Fig. 11. In this View of the Machine in Fig. 10, the Oerlikon-Italiana Unit Head Employed for the Line-reaming Operation may be Seen, also Further Details of the Clamping Arrangements

head is traversed at a speed of 0·5 mm. (0·019 in.) per rev., by means of an air-hydraulic cylinder at one side. Reference has been made, in earlier articles in the series, to these cylinders, which provide for rapid advance to the cutting position, followed by a steplessly-variable feed movement, and rapid retraction. A view from one side of the machine, showing the clamping finger at the right-hand end of the fixture, and a Enots (Benton & Stone, Ltd.) air valve for controlling the clamping cylinders, is given in Fig. 11. Like the milling head, the line-reaming head operates on an automatic cycle, controlled by switchgear in the cabinet at the side of the machine, and it has two spindles, equipped with reamers of 11 mm. (0·433 in.) diameter. These spindles are driven at 450 r.p.m., and the entire head is fed at the rate of 1·5 in. per min. to ream the holes to limits of +0·043 −0·00 mm. (+0·0017 −0·00 in.). At the end of the machine cycle, the heads are retracted, and after the casting has been unloaded it is returned to the bench, where the other two studs are inserted, the dowels are fitted into the reamed holes, and the nuts are tightened.

CIMATIC FINE-BORING MACHINES

The next two series of operations are carried out on a pair of Cimatic 3 UN 2 fine-boring machines, of similar type to that described at the beginning of this article. These machines are arranged facing each other, and, since their automatic cycles are fairly lengthy, they are served by the same operator. Both

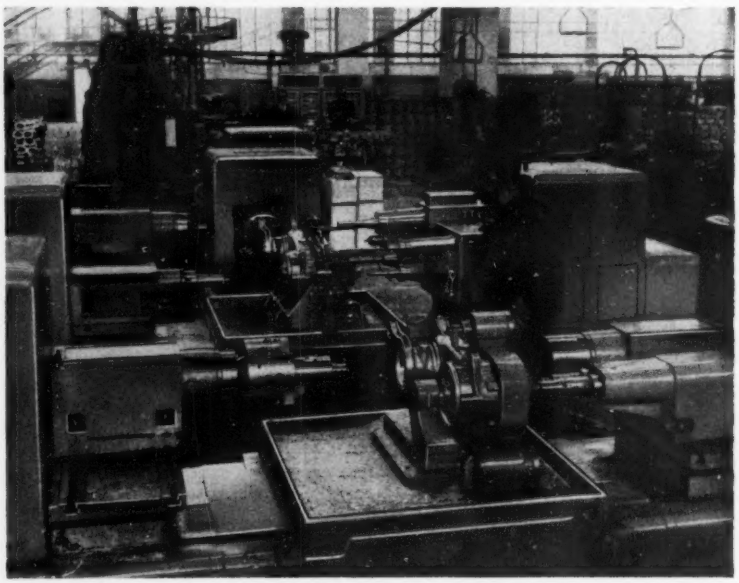


Fig. 12. The Two Cimatic Fine-boring Machines in the Foreground are Employed for Operations on the Crankcase, the Casting *A*, Fig. 9, and the Cover Casting

the machines are seen in the general view of the remainder of the line, in Fig. 12, and the conveyor carrying the castings passes the left-hand ends. On the first machine of the pair, seen in the foreground, a number of boring and facing operations is carried out, and the casting is again located by the original holes *B*, Fig. 3, and clamped with the cover face in contact with a vertical surface on the fixture. A horizontal hydraulic cylinder, at the top of the fixture, has an arm which is applied directly to the triangular boss on top of the casting. Another horizontal cylinder, at the nearer end of the fixture, operates two swivelling arms, which apply pressure to the lower edge of the crankcase casting.

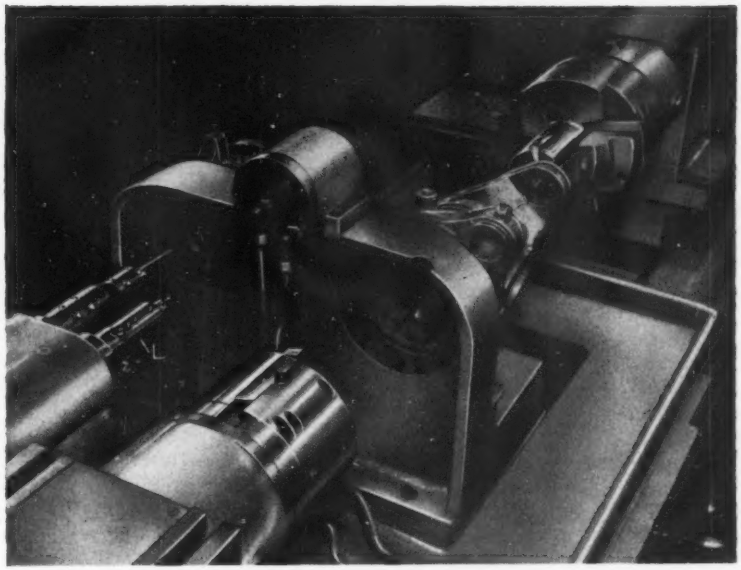


Fig. 13. Close-up View, from the Operator's Side, of the First of the Two Cimatic Machines in Fig. 12, Showing Details of the Tooling for the Facing and Boring Operations. The Head at the Left Machines Bores in the Casting *A*, Fig. 9, and in the Crankcase

In the close-up view of the machine, from the operator's side, given in Fig. 13, some details of the tooling may be seen. The right-hand head has a single spindle for operations on the housing for the flywheel end of the crankshaft, wherein in the casting which carries the crankshaft on a double-row ball bearing is later accommodated. For finishing the various diameters in this housing, the spindle is equipped with two tools, at the nose end, which bore diameters of 15 +0·025 −0·00 mm. (1·772 +0·001 −0·000 in.) for an oil seal, and 52 +0·00 −0·03 mm. (2·047 +0·000 −0·0012 in.) for the ball race at the clutch end of the crankshaft. Two more tools, on the larger portion of the spindle, machine bores of 105·5 ±0·175 mm. (4·153 ±0·007 in.) for the crankshaft throw clearance, and 107 +0·035 −0·00 mm. (4·213 +0·0014 −0·000 in.) for the location of the casting for the ball bearing. In addition, this spindle carries a facing slide, with a tool which operates on the end face of the crankshaft housing, so that the final distance of this face from the end face of the bore *E*, Fig. 3, is 108·5 +0·00 +0·5 mm. (4·272 +0·00 +0·020 in.). This spindle is driven at 610 r.p.m. and is fed at 0·003 in. per rev.

At the left-hand end of the machine, in Fig. 13, there are two heads, one of which has a single-spindle, and the other, two spindles. The single-spindle carries only one tool, which is employed to finish the 162 +0·04 −0·00 mm. (6·378 +0·0016 −0·00 in.) bore in the clutch end of the crankshaft housing, indicated at *K* in Fig. 3. This spindle is driven at 400 r.p.m. The two spindles in the other head carry tools for operations on the bores for the gearbox and axle shafts in the other end of the casting. Some details of these bores, also of the cover casting, are shown in the sectional view of the crankcase in Fig. 14, where the casting *A* is seen in position. The nearer of the two spindles, indicated at *L* in Fig. 13, carries four tools which machine the bores for the gearbox shaft bearings at *M* in Fig. 14. The smaller of these bores is machined to 32 +0·025 −0·00 mm. (1·26 +0·001 −0·000 in.), and the larger bore, in the casting *A*, to 47 −0·008 −0·033 mm. (1·85 −0·00031 −0·0013 in.). In addition, the ends of both the bores are chamfered. This spindle runs at 650 r.p.m.

Two bores, in which are housed the needle roller and ball bearings for the axle shaft, in the casting *A* and the main casting respectively, are machined with the second of the two spindles,

which runs at 476 r.p.m. This spindle is equipped with five tools, one of which finishes the bore *D*, Fig. 14, to a diameter of 52 +0·009 −0·021 mm. (2·047 +0·00035 −0·00084 in.), while a second tool chamfers the end. Another tool is employed to bore the casting *A* to a diameter of 67 +0·03 −0·00 mm. (2·638 +0·0012 −0·0000 in.), to accommodate the outer race of the needle roller bearing, and a fourth tool finishes the remainder of this bore to 70 +0·25 −0·00 mm. (2·756 +0·0098 −0·0000 in.). A fifth tool is employed to chamfer the end of the smaller portion of the bore. The left-hand head is fed at the rate of 1·8 in. per min. Machining of the circlip groove in the bore *M* of the casting *A*, Fig. 14, is carried out during the semi-finishing operations on the part, which are performed on a separate short machining line.

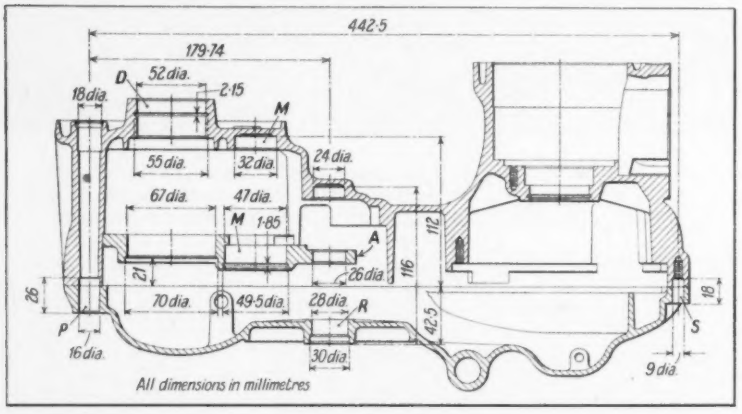


Fig. 14. Sectional View Giving Details of the Bores in the Iron Casting *A*, in which the Gearbox and Rear Axle Shafts are Accommodated, and of the Cover Casting

OPERATIONS ON CRANKCASE AND COVER ASSEMBLIES

From the nearer of the two fine-boring machines in Fig. 12, the crankcase castings are transferred to the further, similar machine. On this second unit provisions are made for machining certain bores, which must be in alignment, in both the crankcase and its cover casting. Examples of cover castings are seen in Fig. 9 and elsewhere, and a section through the longitudinal centre line of this casting is given in Fig. 14. Before the cover castings reach the second Cimatic machine, certain operations, including milling the joint face and facing the internal annular boss *N*, Fig. 9, and its four ribs, are completed on other machines in the line. Holes for the location of the casting at this operation are machined at the foundry. A close-up view of the fixture on the second Cimatic machine is given in Fig. 15, from which it will be seen that the cover casting is clamped to one side of a vertical member and the crankcase to the other side. The location arrangements for the two castings are such that the bore which accommodates the spigot of the cylinder in the final assembly, is in a horizontal position.

For clamping the cover casting, there are four horizontal, short-stroke hydraulic cylinders, the rams of which are equipped with fingers. These fingers are swivelled into position, in front of the casting surface, as the rams are drawn back by oil pressure. Another close-up view, showing the other side of the fixture, is given in Fig. 16. On this side, there are two hydraulic cylinders, the rams of which project from bosses on the vertical face. These bosses enter the bores *D* and *E*, Fig. 3, of the crankcase and rear axle housings, to locate the casting. Each ram has a circumferential groove near the end, and is machined on opposite sides to a width slightly smaller than the groove root diameter. Washers of sufficient diameter to cover the faces adjacent to the bores in the casting, and with elongated holes to pass over the ram ends, are provided. These washers are applied, and turned through 90 deg., so that they engage the ram grooves, before the hydraulic valve, seen at the left in Fig. 15, is operated. This valve also controls the supply of oil to the cylinders on the crankcase side of the fixture, and when it is operated, both castings are clamped simultaneously.

At the right-hand side of the fixture, seen in Fig. 15, there are two heads, of which the nearer has three, and the further two, spindles. Of the three spindles on the nearer head, the upper carries two boring tools and it operates on bores in two suspension brackets, one on each casting. These brackets are bored to diameters of 12 +0·027 −0·00 mm. (0·472 +0·001 −0·0000 in.), and 17 +0·027 −0·00 mm. (0·669 +0·001 −0·0000 in.), for the

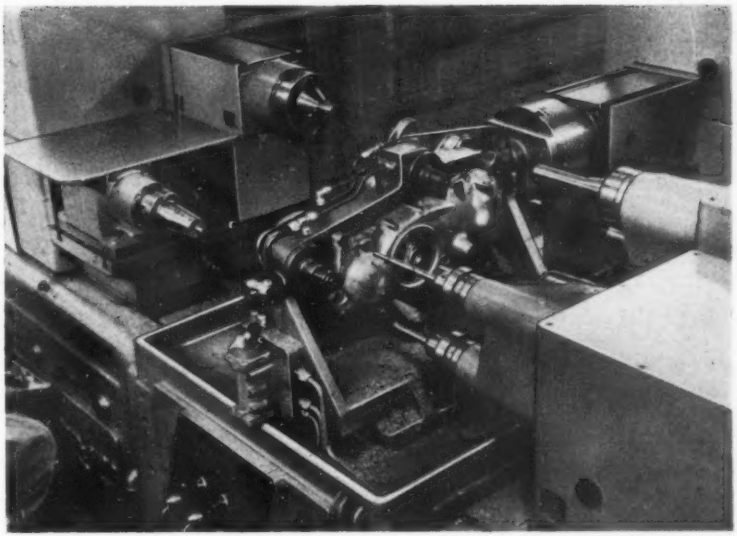


Fig. 15. On the Second of the Cimatic Machines in Fig. 12, Certain Bores in the Crankcase and the Cover Casting are Machined in Line

crankcase and cover, respectively, the boring bar being supported in a bush in the fixture member. In the spindle directly beneath, there is a single tool, which operates on the end of the bore *P*, Fig. 14. The portion machined at this stage extends through the cover and to a depth of 6 mm. (0·236 in.) into the crankcase casting. This bore is fitted with a thin-walled bush in the final assembly, which is one of the locations for the cover in relation to the crankcase. It is bored to a diameter of $16 \begin{smallmatrix}+0{\cdot}027\\-0{\cdot}00\end{smallmatrix}$ mm. ($0{\cdot}629 \begin{smallmatrix}+0{\cdot}001\\-0{\cdot}0000\end{smallmatrix}$ in.) at this operation.

The third spindle of this group is somewhat larger than the others and carries tools for operations on the line of bores indicated at *R* in Fig. 14, in which the shaft for the double roller chain sprocket and the kick-start mechanism is housed in bushes. This boring bar has five tools and serves to finish bores of 24 and 26 mm. (0·945 and 1·024 in.) diameter in the crankcase and the casting *A*, Fig. 14, respectively, to limits of $+0{\cdot}021$ $-0{\cdot}00$ mm. ($+0{\cdot}00084 - 0{\cdot}0000$ in.), also a stepped bore of $28 \begin{smallmatrix}+0{\cdot}021\\-0{\cdot}00\end{smallmatrix}$ mm. and $30 \begin{smallmatrix}+0{\cdot}033\\-0{\cdot}00\end{smallmatrix}$ mm. ($1{\cdot}102 \begin{smallmatrix}+0{\cdot}00084\\-0{\cdot}0000\end{smallmatrix}$ and $1{\cdot}181 \begin{smallmatrix}+0{\cdot}0013\\-0{\cdot}0000\end{smallmatrix}$ in.) diameter, in the cover casting. The outer end of the bore in the cover casting is also chamfered by one of the tools on this bar. Of the further group of two spindles, at the right-hand side of the machine, the upper has two

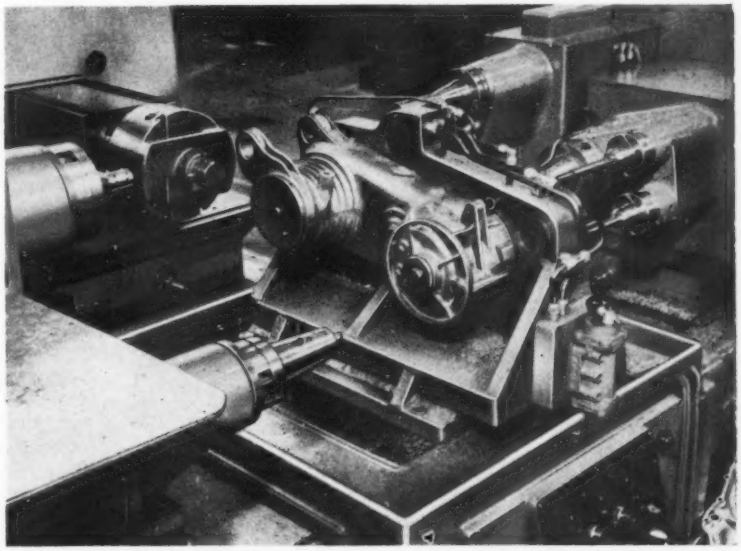


Fig. 16. View, from the Opposite Side, of the Fixture on the Machine in Fig. 15. The Castings are Inclined at an Angle of 10 deg. to Facilitate the Machining of the Cylinder Spigot Bore and Face

tools to bore and chamfer the wider of the two suspension lugs at the front end of the crankcase to a diameter of $38+0.025-0.00$ mm. ($1.496+0.001-0.0000$ in.). In the other spindle is mounted a 3-bladed cutter which finishes the bore S, Fig. 14, to a diameter of $9+0.036-0.00$ mm. ($0.354+0.0014-0.0000$ in.), for a depth of 18 mm. (0·708 in.), of which 6 mm. (0·236 in.) is in the crankcase casting. On assembly, a flanged bush similar to those employed to locate the casting A, Fig. 9, is fitted in this hole to position the cover correctly in relation to the crankcase casting.

The spindle speeds employed for these operations range from about 5,000 r.p.m. for the smallest diameter to 1,650 for the largest, and the feed rate is approximately 1·5 in. per min. At the left-hand side of the fixture there are two single-spindle heads, and the spindle at the front carries two tools that bore and chamfer the other end of the hole *P*, Fig. 14, for the reception of a bush which carries the cam end of the brake-operating shaft. This bore is finished to $18+0.027-0.00$ mm. ($0.708+0.001-0.0000$ in.), for a depth of 22 mm. (0·866 in.). The other spindle is also provided with two tools, for boring and chamfering the narrower of the two suspension lugs at the front end (in the scooter) of the crankcase, to the same diameter and limits as for the other lug, already mentioned. The two spindles at the left head are driven at speeds of 4,000 and 1,650 r.p.m., and are fed at 1·5 in. per min.

In addition to the spindle heads at each side of the fixture, there is a fifth head, which is mounted on horizontal ways, on an extension to the bed casting at the rear. This head is employed to machine the bore in which the cylinder spigot is located on assembly, and its adjacent face. It will be recalled that the casting is so mounted in the fixture that this bore can be machined with a horizontal head. A single spindle, equipped with a boring tool and facing slide, is employed, and the bore is finished to a diameter of $67+0.19-0.00$ mm. ($2.638+0.0075-0.0000$ in.). For machining the mounting face, the spindle speed is 450 r.p.m., and the feed rate, 0·0028 in., per rev. As on the other Cimatic machines in this line, the cycle is completely automatic, after the work has been loaded and a button pressed, and the floor-to-floor time for each of the machines in Fig. 12 is 2 min. On these machines, the crankcase castings are completed, apart from minor operations, but further machining is required on the cover casting.

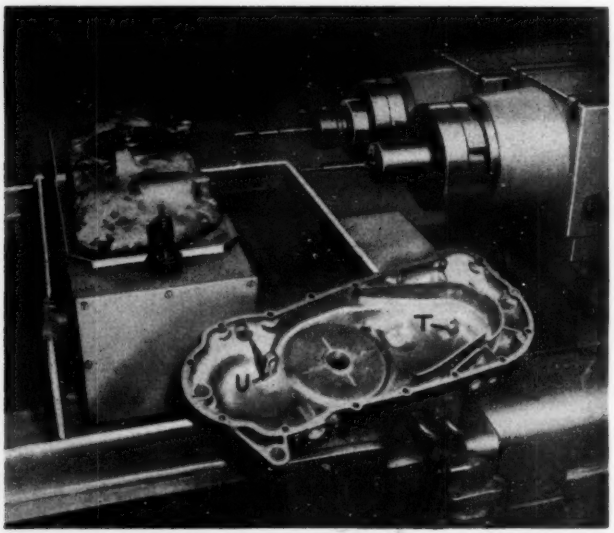


Fig. 17. Two Lines of Bores for the Clutch and Gear-change Shafts in the Cover Casting are Finished at this Set-up on a Single-ended Cimatic Machine. The Rear Spindle Carries a 5-toothed Cutter for a Facing Operation

FURTHER OPERATIONS ON COVER CASTINGS

From the Cimatic machine shown in Figs. 15 and 16, the cover castings are passed to another, smaller, Cimatic fine borer. A close-up view of the tooling on this machine, which is of the single-ended type, is given in Fig. 17, and the casting is loaded face downwards on the fixture, where it is located by dowels in the holes *P* and *S*, Fig. 14. It is then clamped by a hydraulic cylinder at each end of the fixture, which applies a finger to the casting surface. Here, again, the fingers are turned as they are lowered, so that they overlap the casting. A stud, which projects upwards through the bore *R*, Fig. 14, carries a knurled nut. A plate of sufficiently large diameter to cover the annular ridge surrounding the bore, and with a captive C-washer, is placed in position, and the nut is tightened by hand to prevent vibration of the work. The front spindle on this machine is fitted with a combined drilling and boring tool, and the drill portion passes through a cored boss at the side of the cover, to drill a 6-mm. (0·236-in.) diameter hole in a small boss, indicated at *T* in Fig. 17.

Other tools mounted on the front spindle finish a bore in the outer boss to 12 +0·110 −0·00 mm. (0·472 +0·0043 −0·0000 in.), and a counterbore to 16·7 +0·043 −0·00 mm. (0·6575 +0·0017 −0·0000 in.), and chamfer the end. This bore accommodates the clutch-operating shaft of the assembled engine unit. The rear spindle provides for operations on bores for the gear-change shaft, and carries a drill-reamer which finishes a bore in the boss *U* to 10 +0·036 −0·00 mm. (0·3937 +0·0014 −0·0000 in.). Other tools on this spindle bore an outer boss to 17 +0·043 −0·00 mm. (0·669 +0·0017 −0·0000 in.), counterbore it to 22·5 +0·33 −0·00 mm. (0·886 +0·013 −0·0000 in.), and chamfer the end. Finally, a 5-tooth cutter is used to spot-face the end of the boss. These operations are carried out at a spindle speed of 2,600 r.p.m., with a feed of 1·5 in. per min.

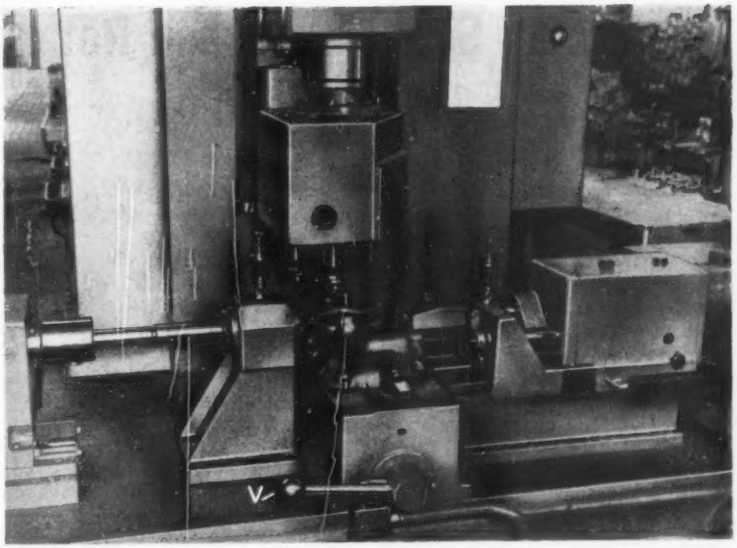


Fig. 18. This Oerlikon-Italiana Machine is Equipped for Drilling, Spot-facing, and Boring Holes in the Cover Casting for a Rubber Buffer, Oil Drain Plugs, and a Bracket which Carries the Control Cables

Next, the cover casting is transferred to the special Oerlikon-Italiana drilling and boring machine shown in Fig. 18. On the central fixture of this machine, the casting is loaded, face downwards, and located as at the previous operation. Mechanically-operated clamps are applied to the ends of the casting by cams on a shaft which is turned by means of the lever *V*. In addition, a small toggle clamp is applied to one edge, about half-way along. There are two unit heads on the right-hand side of the fixture, and the front head has two spindles equipped with drills of 2 and 2·25 mm. (0·078 and 0·088 in.) diameter, which drill holes in bosses on the top and at the side of the casting, respectively. The rear head at the right also has two spindles, which drill 6-mm. (0·236-in.) tapping holes in the face machined by the 5-tooth cutter at the previous stage. At the left-hand side of the fixture, there is a single head, with one spindle carrying a combination tool for core-drilling and spot-facing a boss on top of the casting. This boss accommodates a rubber buffer for the kick-start lever in the assembled unit. The bore is finished to a diameter of 20 +0·13 −0·00 mm (0·787 +0·005 −0·00 in.), and the end is chamfered.

Above the fixture, there is another unit head, with two spindles fitted with combination tools for drilling and spot-facing two bosses for drain plugs, which are later tapped to 16 mm. (0·63 in.). The spindle speeds on this machine range from 2,500 to 4,500 r.p.m., and feeds of 1 to 1·8 in. per min. are employed. Next, the castings are passed to a line of Rosa (William Urquhart), pillar drilling machines, equipped with simple fixtures, on which various holes are tapped.

Finally, the crankcase and cover castings are inspected with semi-automatic Solex equipment.

CORUNDEX NON-SLIP FLOORING. A product known as Corundex, which has been introduced to the British market by Exsud (South American Minerals & Products Co., Ltd.), Home Industrial Division, 26 and 27 Cowcross Street, London, E.C.1, is claimed to provide a hard wearing, non-slip surface. Supplied in the form of small chips, it is intended to be sprinkled on a freshly laid concrete floor or screed, and then rolled or trowelled into the surface. It is stated that 1 cwt. is sufficient for 350 sq. ft. of concrete.

Marbaix Special-purpose Rotary Transfer Machine

The special-purpose rotary transfer machine shown in Fig. 1 has been designed by Marbaix Industries, Ltd., Valiant House, Vicarage Crescent, London, S.W.11, for machining a fuel pump component. Mainly of weld-fabricated steel construction, the machine has a bed which, in plan, is approximately a square with the corners cut off. At the centre of the base there is a circular pedestal which supports an 8-sided central column of close-grained cast iron, whereon the vertical unit heads are mounted. Surrounding the pedestal is a deep annular ring of cast iron, the sides of which taper inwards at an angle of 8 deg. to the vertical. This ring forms a bearing for the 36-in. diameter annular table which surrounds it, and it can be adjusted vertically, by means of screws, to take up any play due to wear. The table is of approximate box section and incorporates a steel ring with hardened steel inserts, provided with accurately-machined indexing slots, in its outer edge. This ring is attached to the under-side of the table and rests on a wide-faced annular bearing ring of phosphor bronze, which has circular overlapping oil grooves machined in its upper surface. The method of indexing the table is clearly shown in the plan view in Fig. 2. Here, the table is seen complete at the right-hand side, together with the 3-jaw chucks on its upper surface, in which the components are clamped, and the adjustable cast-iron bearing ring is indicated at *A*. On the left-hand side, the upper part of the table is cut away, so that the indexing ring and its inserts may be seen.

The slot in each indexing ring insert is of special shape, with one edge radial and the other inclined at an angle of 45 deg. The indexing pawl *B* has surfaces which are machined at similar angles, and is held in a slot in a horizontal arm *C*, carried on a double taper-roller bearing at the centre of the pedestal. The ram of a Lang Pneumatic, trunnion-mounted, 6-in. bore, air cylinder *D* is connected to the arm *C*, which can be moved by this cylinder to the position shown chain-dotted, and back, for the indexing operation. Another air cylinder *E*, of 4-in. bore, mounted in a vertical position on the machine base, provides for clamping the table through a lever *F*, which is brought down on to a flange projecting from the lower side of the table, above the steel indexing ring. All the movements of this indexing mechanism are signalled to the control cabinet of the machine, seen at the left in Fig. 1, by means of limit switches. Consequently, the next movement in the cycle cannot be initiated until the previous one has been completed.

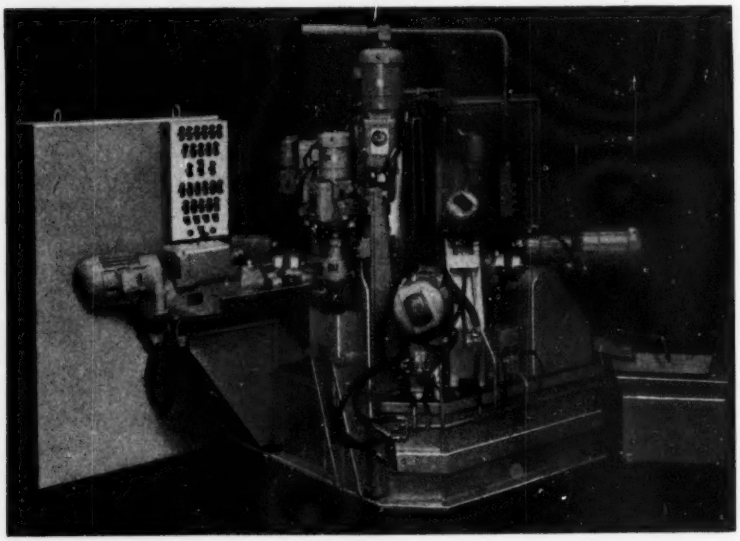


Fig. 1. General View, from the Left of the Loading Position, of the Marbaix Special-purpose Rotary Transfer Machine for Operations on Fuel Pump Components

For indexing, air is

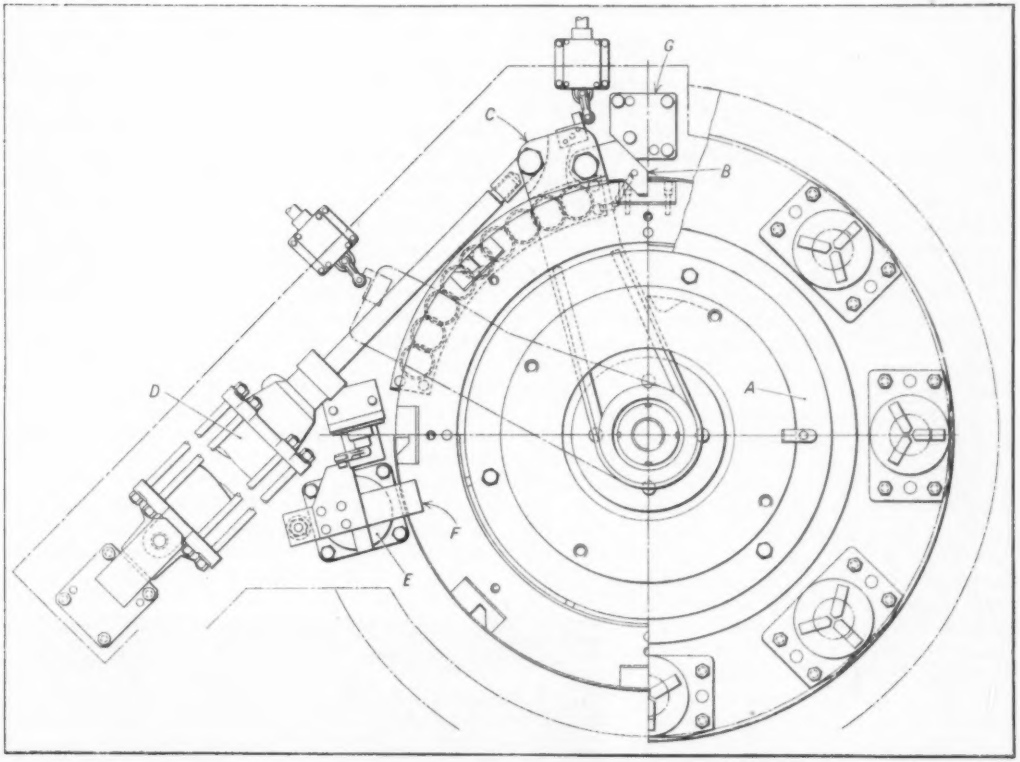


Fig. 2. In this Plan View of the Indexing Arrangement for the Annular Table of the Marbaix Machine, the Bearing Ring and Part of the Table have been Omitted at the Left-hand Side

first supplied to the ram side of the piston in the cylinder *D*, so that the arm *C* is drawn back until the spring-loaded pawl *B* enters the next slot in the table. At the end of this movement, a dog on the end of the arm operates a limit switch, with the result that a circuit is completed to a solenoid valve which allows air to pass to the underside of the piston in the cylinder *E*, so that the table is unclamped. On completion of the stroke of the ram of this cylinder, a limit switch is operated to reverse the direction of the air supply to the cylinder *D*. The arm *C* is thus moved forward, so that the table is turned through 45 deg. Towards the end of the stroke of the ram in the cylinder *D*, the rear face of the pawl *B*, which is also cut away at an angle of 45 deg., comes into contact with a face machined at a similar angle on a fixed block *G*, screwed and dowelled to the machine base-plate. The arrangement is such that a wedging action is obtained, which accurately positions the table within ±0·0015 in., without the need for separate locating plungers, and, at the same time, effectively locks the table in position. Finally, the table is clamped by the reversal of the air supply to the cylinder *E*. The entire operation of indexing occupies a period of only 3 sec.

The outside rim of the annular table projects slightly over the edge of an annular channel-section trough, which surrounds the table and catches swarf and spent coolant. Blades attached to the table project into the trough so that, as the table is turned, the swarf is swept round to a position whence it passes down a chute leading to the coolant tank. A filter on this tank prevents the entry of swarf, and is surrounded by inclined sides so that the swarf may be cleared away at intervals. On the top surface of the table there are eight Burnerd, 5-in. diameter chucks, spaced at 45 deg.

The component is machined from a 1-in. length

of carburized steel bar, of 2½ in. diameter. There are two transverse bores at 90 deg. to each other, with their outer ends threaded. One bore is of uniform diameter and the other has several steps, and must be held to close limits for concentricity and size. In the top surface of the workpiece, there are two curved parallel-sided grooves, measuring 5·6 mm. wide by 2·7 mm. deep, on a pitch circle of 28·5 mm. diameter. In one of these grooves, two holes of 5·18 mm. diameter are drilled to break into the larger of the two main bores. In the other groove, a hole of similar size is drilled at an angle of 35 deg., to communicate with the inner end of the smaller bore. In addition, there are four fixing bolt holes, of 5 mm. diameter, which pass right through and must be accurately positioned, and two dowel holes of 3·2 mm. diameter, drilled to a depth of 4·5 mm. in the top surface.

Loading and unloading is carried out at the position to the right of the horizontal head seen at the left in Fig. 1, the blank being placed in the chuck, and the jaws tightened by means of a captive, capstan-type key, held in a bracket at the side of the table. At the next indexing movement, initiated by pressing a button on the control panel, the blank is carried in a clockwise direction, viewed from above, to the position served by the head at the extreme left in Fig. 1. All the drilling and reaming operations on this machine, it may be noted, are carried out with Delta-Milwaukee air-hydraulic drill units, which are made under licence in this country by Gaston E. Marbaix, Ltd., Devonshire House, Vicarage Crescent, London, S.W.11, and were fully described in MACHINERY, 78/911—31/5/51 and 84/283—5/2/54. The unit head employed at the first machining station is the 19-600 type, and is the largest in the range, having a capacity for drilling holes up to 1 in. diameter. This head is fitted with a stepped drill, with diameters of ¼ in. and ⅛ in., and the larger diameter portion is fed to a depth of 37 mm.

At the same station, a special milling head, mounted on one of the faces of the central column, is brought into operation to cut one of the curved slots, mentioned earlier. This head is indicated at *H* in Fig. 3, which shows the machine from the rear, and was designed by Marbaix Industries, Ltd. A part-section side elevation of the head is shown in Fig. 4, and it incorporates an electric motor with its axis vertical. Extending downwards through the housing, the motor spindle carries a chuck at its lower end, in which a 2-bladed milling cutter is held. Provision is made for the motor housing to move vertically, in its supporting brackets, in order that the milling cutter may be fed into the work to the required depth. To permit this movement, the motor is supported on a number of coil springs *J*, housed in bores in the upper support bracket, the weight being taken on a thrust race *K*. Above the motor housing there are two horizontal levers, seen at *L* in the front elevation of the upper portion of the unit in Fig. 4, which are pivoted on one of the main support brackets. Each lever carries a central roller, as at *M*, which rests on a hardened annular surface at the top of the motor housing. At the outer end of each lever there is another roller *N*, which is held, by the springs *J*, in contact with surfaces at the outer ends of a cam *P*.

This cam *P* is carried on a horizontal spindle, which is driven through one revolution, when the head is brought into use, by a small, externally-mounted, geared motor unit. When the cam is

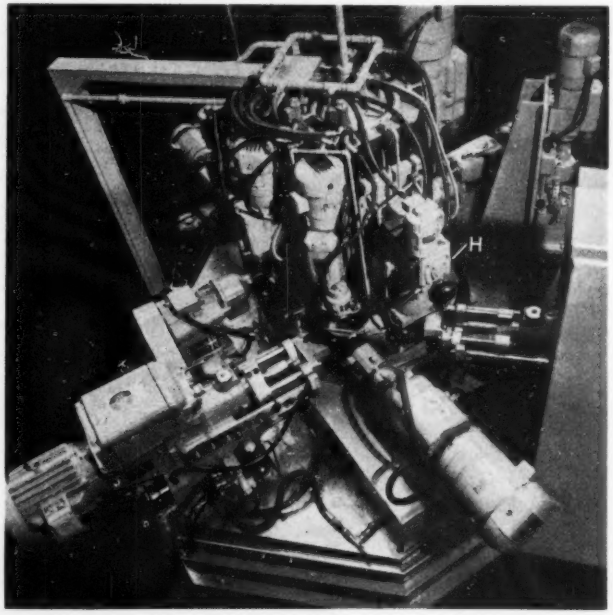


Fig. 3. In this View from the Rear, the Loading Station is Shown on the Right, also the First Machining Station, at which the Head *H* is Employed for Cutting One of the Two Curved Slots in the Face of the Component

rotated, the motor housing is fed downwards, so that the cutter enters the work to the depth of the slot to be cut—namely 2·7 mm.—and it is held at this level during the milling operation.

The motor housing has integral bosses at the top and bottom, which are off-set from the spindle axis by an amount equal to the radius of the circle on which the groove is to be machined, namely 14·25 mm. These bosses fit accurate bores in plates which form part of the weld-fabricated supporting bracket for the head. Provision is made for the entire motor housing to be turned in these bores, for the purpose of cutting the groove, and this movement is effected by means of the cam *P*, which has a helical groove machined in its surface. A roller *R*, seen in the front elevation in Fig. 4, is secured to the top of the motor housing, and engages the cam groove. Consequently, when the cam is rotated, the housing is turned so that the cutter is traversed in a curved path, through a total angle of 70 deg., and then returned to its starting point. The design of the cam *P* is such that the cutter is first fed to depth, then traversed for the full distance, retracted from the work, and finally returned to the original position. With the spindle motor running continuously, it is only necessary to start the small cam-driving motor to carry out the grooving operation, and this motor is switched off automatically, by means of a limit switch operated by a projection on the motor housing, when the latter has returned to its starting position.

Two Delta-Milwaukee unit heads are mounted in horizontal positions at the next machining station, and are seen in the foreground in Fig. 3. The head on the right is a type 19/400, and the head on the left, a type 19/600, with drilling capacities up to ½ and 1 in., respectively. The smaller of these heads is equipped with a tool designed for facing the outside end of the hole drilled at the previous operation, to give an overall dimension of 61 mm. Preliminary drilling of the other stepped, horizontal bore, at 90 deg. to the first, and chamfering of the outer end, is carried out with the larger head at this stage. The face of the central column at this position carries a 19/150 unit head—the smallest in the range—with a capacity for drills up to ⅝ in. diameter, which is fitted with a Slack & Parr, 2-spindle, gearless-type, fixed centre drill head. One of these spindles carries a No. 6 drill, of 5·18-mm. diameter, which is employed for drilling a connecting hole into the larger of the two horizontal bores, and the other with a drill of 3·3 mm. diameter for one of the two small dowel holes. A similar head is mounted in a vertical position at station 3 for drilling the other hole of each pair.

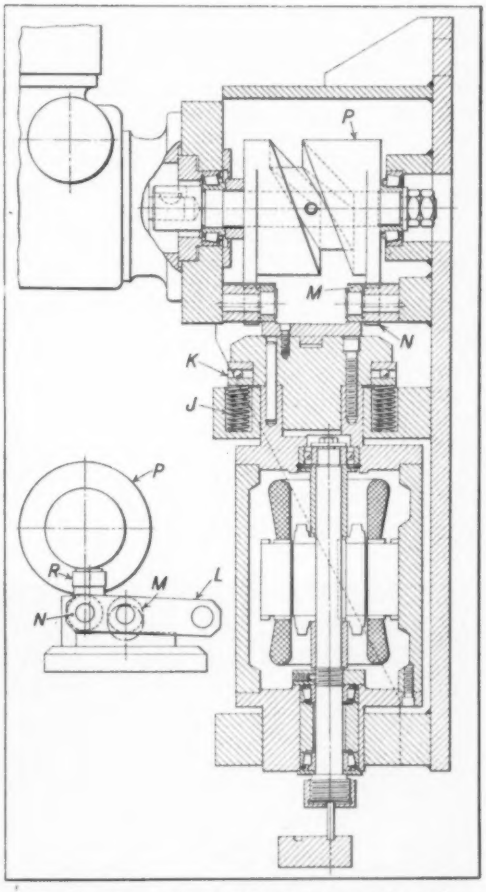


Fig. 4. Part-sectional Side Elevation of One of the Special Heads for Milling the Curved Slots

At station No. 4, a Snow, air-operated, tapping unit (Gaston E. Marbaix, Ltd.), seen at the extreme left in Fig. 3, is employed to tap the larger of the two horizontal bores ¾-in. by 16 U.N.F. In addition, a 19/400 Delta-Milwaukee unit, fitted with a stepped drill, completes the second horizontal threaded bore in the workpiece. For milling the second curved slot, also at station No. 4, a special unit, of similar design to that described earlier, is mounted on one face of the central column, the design of the control cam being modified so that the head is turned in the opposite direction. The next station (No. 5), is equipped with another Snow tapping unit, whereby the second horizontal bore is tapped ⅞ in. by 28

U.N.F., to a depth of 10 mm. At this station there is also a 19/150 type drill unit, set at an angle of 35 deg., on a special column at one side of the base, for drilling a 5·18-mm. diameter hole from the end of one of the curved slots into the second horizontal bore. Station No. 6 is employed solely for line-reaming two of the four steps in the second horizontal bore, to diameters of 11·1 and 13·3 mm., with a 19/400 unit head. Another unit head of this type is mounted on the face of the central column at the seventh station, and is fitted with a Slack & Parr 4-spindle drill head carrying 5-mm. drills for the four mounting stud holes. On being indexed to the next station, the component is unloaded from the chuck and another blank is loaded in its place.

De-burring of the four holes drilled at the last machining station, on the plain side of the component, is next carried out with the aid of the equipment seen at the right of the loading station in Fig. 1, during the next machining cycle. A close-up view of this equipment is given in Fig. 5, and in addition to de-burring, it is designed to stamp two characters on the plain side of the component. A pot-type fixture with two locating dowels is provided for the work, which is loaded with the slotted side downwards, and held in place by a swivel-mounted bar S. On the under-side of this bar there are two stamps for marking the component face, and a projection at the left-hand end operates a limit switch as the bar is moved into place. A spring-detent holds the bar in the advanced position, in which a slot in one end is engaged beneath the mushroom head of a pin projecting from the fixture face. Above the fixture, is mounted a 19/150 drill unit, which is fitted with a 4-spindle head carrying drills of suitable size for the de-burring operation. Beneath the fixture there is a British Bellows impact-type air cylinder (Benton & Stone, Ltd.), which is employed for the stamping operation. These cylinders were described in MACHINERY, 90/435—22/2/57, and each incorporates a built-in accumulator which allows air pressure to reach a maximum value before the energy thus stored is suddenly released, so that a heavy blow is struck.

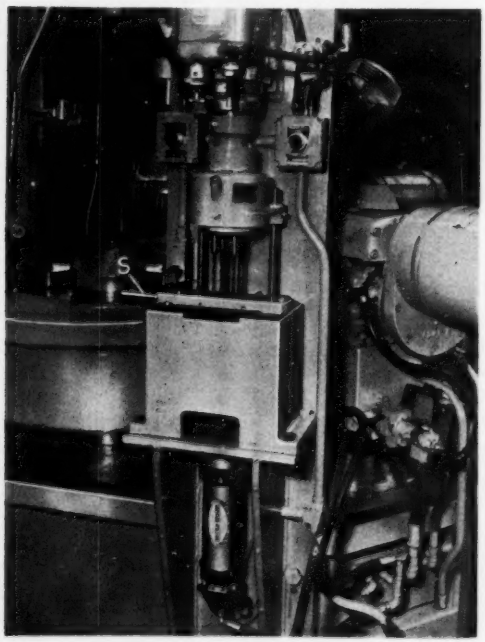


Fig. 5. Close-up View of the Equipment Provided at One Side of the Loading Station for De-burring the Edges of the Mounting Stud Holes Drilled at the Final Station, and Stamping Two Characters in the Surface of the Blank

After placing the component in the fixture and moving the swivelling bar into position, the two push-buttons, above and on each side of the drill head, are depressed simultaneously. A solenoid valve is thus operated to admit air to the impact cylinder, so that the ram shoots upwards, forcing the component against the stamps on the lower surface of the bar S, to form the required impressions. The ram then remains in the raised position, holding the component against the under-side of the bar, until the drills have been fed down, through bushed holes in the bar, far enough to remove any burrs from the holes. As soon as the drills have reached their lowest point and started to retract, the operation of a limit switch reverses the setting of the solenoid valve for the impact air cylinder, so that the ram is withdrawn, and the component can then be unloaded. The cycle time for the operations described is 46 sec.

All the machine movements are interlocked with the aid of Square-D limit switches, so that all the machining operations must be completed before the indexing motion can be initiated by the operator. In addition, there is a control panel at the operator's position with sets of red and green lights. Red lights are illuminated when each head moves forward from its retracted position, and green lights indicate that the individual driving motors are running. A pendant control is provided which carries a selector switch to enable the individual heads to be operated when setting-up or changing tools, also starting and stopping buttons for the automatic cycle, and a master stop button.

Four-spindle Boring Machine with Punched Tape Control

To meet a need for greater automation in the aircraft industry, a horizontal precision boring machine has been developed specifically for use with a 2-motion numerical positioning control system. This 4-spindle machine was specially designed for operations on components for J-79 and CJ-805 jet propulsion units, and is shown in the general view, Fig. 1.

The machine, which was built by the Barnes Drill Co., Rockford, Ill., U.S.A., is intended for boring cylindrical parts ranging up to 50 in. diameter and 40 in. long. A 55-in. diameter rotary table, powered by a 1½-h.p., 280-r.p.m. motor, can be turned through a full 360 deg. at a speed of approximately ⅜ r.p.m. It will index from a given reference point with a positional tolerance of 0·005 in. at 50 in. diameter—repeatable within 0·001 in. The table is equipped with a lifting mechanism to ensure easy rotation and a clamping arrangement for locking. A close-up view of the machine from the rear, showing the indexing table, is given in Fig. 2.

Machining is carried out with a 4-spindle, heavy-duty boring head mounted on a compound slide. Each spindle is individually controlled and has three different feed rates. Driven by a 1-h.p. motor, the boring head can be moved vertically at a speed of 60 in. per min. through a maximum distance of 40 in. Like the rotary table, the head will locate with a position tolerance of 0·005 in.—repeatable within 0·001 in.

Numerical positioning control equipment for the machine was designed and built by the Speciality Control Department of the General Electric Co., Waynesboro, Va. Punched paper tape controls the rotary motion of the work-table and vertical motion of the boring head, for positioning for such operations as spot-facing, boring, reaming, tapping, and chamfering. In addition, the tape governs the operation of the machine, such as the spindle to be used, the speed of that spindle, the feed rate and the depth of cut. It also gives instructions to the machine such as "position only" or "drill," "dwell" or "no-dwell," and instructions to the operator at any point in the programme. As many as four operations can be performed on any particular hole. An important advantage of this control system is the ability to select hole size, depth, and position in a period of approximately 2 sec.

Fig. 1. A Total of 248 Holes is Finish-bored, Spot-faced, and Back-counterbored in a Jet Propulsion Unit Compressor Casing, During an Uninterrupted Sequence, on this 4-spindle, Tape-controlled Machine. The Holes are of Three Different Diameters. An Alignment Telescope is Used to Position the Casing on the Rotary Table

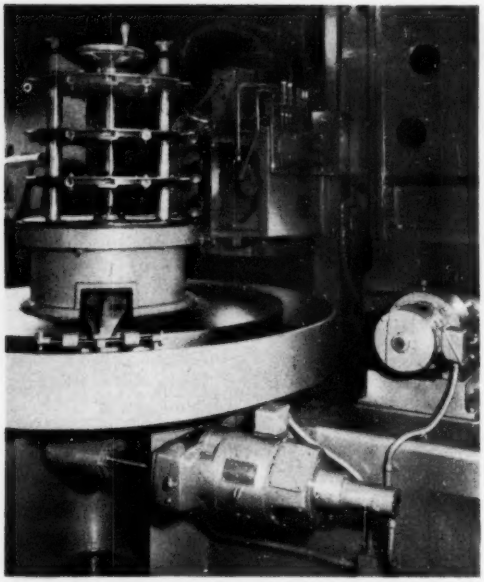


Fig. 2. A View of the 4-Spindle Numerically-controlled Boring Machine from the Rear. The Work-holding Fixture is Initially Positioned on the Rotary Table by the Two Adjusting Screws Seen at the Front of the Table to the Left

Information for vertical positioning is punched in the tape in increments of 0·001 in., which is the smallest increment that can be recorded for this movement. Rotary-indexing information is punched in terms of degrees, and decimal parts of a degree. The smallest unit that can be recorded is 0·002 deg. This unit, when converted to a linear dimension, represents 0·001 in. on a 27½-in. radius.

All positioning is related to a common reference point to avoid the possibility of cumulative errors as the operation proceeds. The necessary information is taken directly from the drawing in coded decimal form. It can then be punched into standard 8-channel paper tape, on any commercial controls typewriter. The tape reader used with the control equipment is a standard commercial unit, equipped with a magazine for storing 100 ft. of endless tape.

Lubrication is provided at all the points required on the machine by an automatic system, and signals give warning of low oil level or broken pipes. Spindles in the boring head are lubricated by an oil mist.

Greenbat Electric Battery Truck with Fixed Platform

The 10-ton capacity electric battery truck with fixed platform, here illustrated, has recently been constructed by Greenwood & Batley, Ltd., Armley Road, Leeds, for the Atomic Energy Commission. Power-assisted steering is provided for all six wheels, and comes into operation automatically, as soon as the steering wheel knob is depressed. With this arrangement, the vehicle can be manœuvred very easily when fully loaded.

Measuring 72 in. long by 48 in. wide, the platform is at a height of 18 in. Solid rubber tyres, of 22 in. diameter by 7 in. tread, are fitted on the driving wheels, and of 16 by 8 in. on the trailing wheels. The maximum speed on the level, with a 10-ton load, is 4 to 5 miles per hour. A 4-speed cam-drum travel controller is provided, and current is supplied by a Nife battery of 300 ampere-hours capacity.

Greenbat 10-ton Capacity, Fixed Platform, Electric Battery Truck

Special Point Form for Twist Drills

The Cincinnati Lathe & Tool Co., Cincinnati, Ohio, U.S.A., have developed a special point form for twist drills, which is claimed to have a number of advantages. A close-up view of the end of a spiral-point drill, as it is termed, is given in Fig. 1. As will be seen from the diagram, Fig. 2, the point angle blends with a small radius r near the axis, so that a central projection is formed. This projection has a sharp point, as indicated at X, which, it is claimed, ensures a self-centring action of the drill at the beginning of the cutting operation, so that holes can be drilled accurately for position without the use of guide bushes or the provision of centre punch marks. As compared with a conventional drill, the new form also gives a smaller negative rake angle near the axis, a higher shear angle, and increased chip space in front of the cutting edge. As a result, an improved cutting action is obtained, and it is stated that the axial load applied to the drill can be reduced by as much as 34 per cent. It is also claimed that drills with a spiral-form point enable holes of improved accuracy as regards roundness, straightness and diameter to be produced, and that subsequent reaming is frequently unnecessary.

In Fig. 3 are shown two views of a drill with a spiral-form point of 180 deg. angle, for drilling sheet metal. In addition to providing a self-centring action, the projecting portion causes the work material to bulge at the centre of the hole as the drill breaks through, and the cutting edges at the periphery have a trepanning action. As a result, snatching, and the formation of burrs, are virtually eliminated. These features enable holes to be drilled to a high degree of accuracy for roundness, notably in aluminium alloys.

The Spiropoint twist drill grinder, which has been developed by the company for producing spiral form points, is shown in Fig. 4, and a

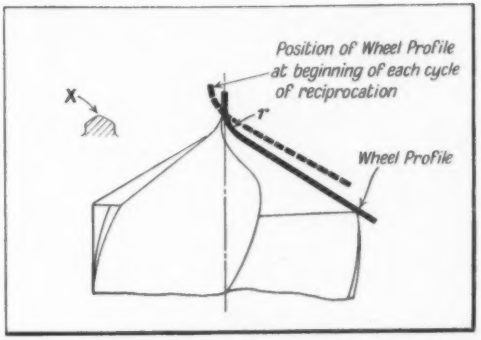


Fig. 2. Diagram Showing the Spiral-form Point and the Method of Generation

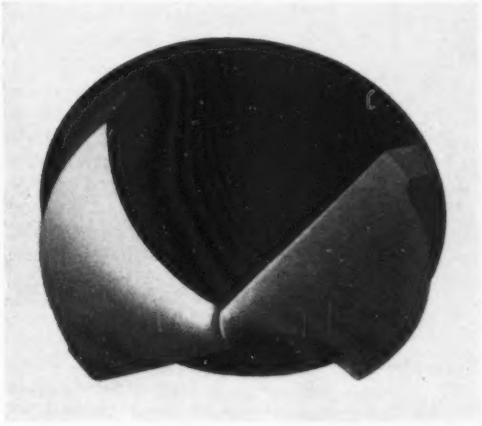


Fig. 1. Close-up View of a Twist Drill with a Spiral Form Point

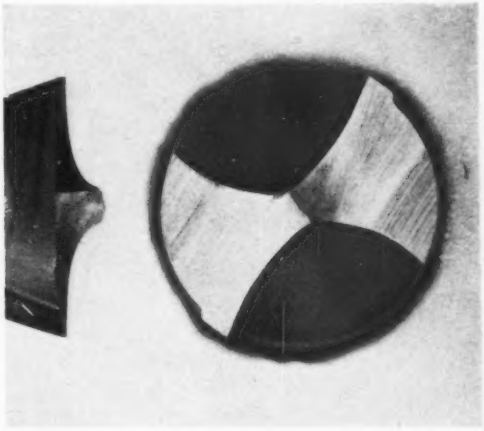


Fig. 3. Views of a Drill with a Spiral Form Point for Use on Sheet Metal

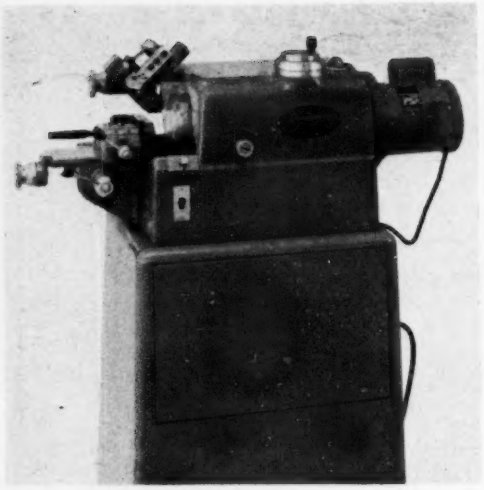


Fig. 4. Cincinnati Spiropoint Twist Drill Grinder for Producing Spiral-form Points

close-up view is given in Fig. 5. The drill to be sharpened is held in a vice and is located for angle by a bush mounted in a bracket, which can be swung clear when the drill has been gripped. The vice is then advanced so that the drill is brought into engagement with the grinding wheel. Grinding is carried out by a small-diameter cup-shaped wheel on which a bevel is dressed to suit the point angle to be produced on the drill. An adjustable dressing attachment is provided which enables different bevels, for grinding point angles from 90 to 180 deg., to be formed on the wheel.

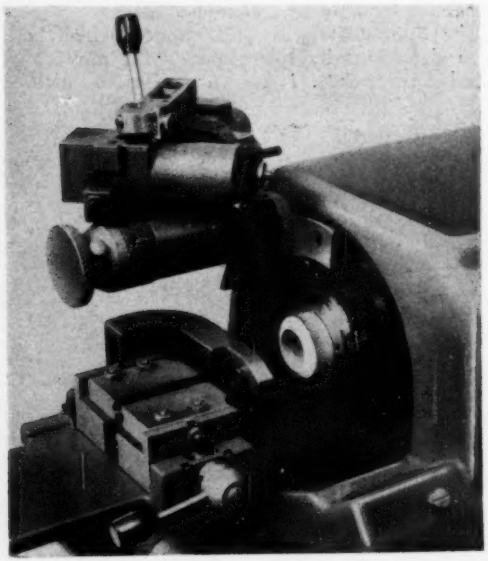


Fig. 5. Close-up View of the Twist Drill Grinder Shown in Fig. 4

During the grinding cycle, the entire wheel spindle assembly is rotated about the centre line of the drill, and, at the same time, is moved radially and axially, as indicated in the diagram Fig. 2, by the action of cams. Two cycles of radial and axial movement are imparted to the wheel spindle during each complete revolution of the housing for producing the spiral form on the drill point. The radial and axial movements can be varied, to suit drills of different diameter, by means of a handwheel on top of the spindle head. A separate knob is provided which enables the amount of relief produced on the drill point to be adjusted.

A RANGE OF METALLIC BORIDES is now being marketed in this country by Borax Consolidated Ltd., Borax House, Carlisle Place, London, S.W.1. There are two series of these borides, one of high chemical purity (not less than 99·8 per cent), and the other comprising technical grades with a purity of the order of 99 per cent. Several borides of the more important metals such as chromium, molybdenum and tungsten are included in one or both of the ranges, as well as the borides of some of the less common metals including titanium, zirconium, vanadium, niobium and tantalum.

Because of their high melting points (up to 3,100 deg. C.), and their hardness, metallic borides are of considerable metallurgical interest. Their corrosion resistance, both to noxious gases and to liquid or gaseous metals, has stimulated research into the possibilities of applying them in gas turbines. Various research organizations are investigating techniques for producing parts by powder metallurgy, and forming coatings on metals or alloys. Borides are employed in "cermet" metal-ceramic compounds, and it is suggested that they may also find application for tools and dies.

PRODUCTION OF COAL CUTTERS in the U.K. during the first and second quarters of 1957 was 146 and 177 units, respectively, and 21 and 39 units were exported. For the corresponding period in 1956, 201 and 192 coal cutters were produced, and 27 and 25 machines were exported.

Special Stretching Equipment for Large Wing-skin Panels

By O. L. RUMBLE*

Certain wing-skin panels for DC-8 jet-propelled airliners which are now being built at the works of Douglas Aircraft Co., Inc., at Long Beach, Calif., U.S.A., are subjected to a stretching operation, for which a special machine of large capacity has been installed. After various alternative methods of construction had been considered, it was decided to employ skin panels in which a wing portion, with dihedral and sweep-back, is blended with a root portion which extends to the centre-line of the aircraft. To obtain the required result, a contour-forming operation is necessary on the root, and it is for this purpose that the stretching press has been provided. With the selected wing construction, the optimum strength-weight ratio for the specified fatigue life is obtained.

Aluminium sheets from which the skin panels are cut are rolled on what is claimed to be the largest tapered-sheet mill in the world, which is installed at the Davenport, Iowa, works of the Aluminium Company of America. The 1,200-lb. skin sheets are tapered longitudinally from 0·210 to 0·130 in., and they are 46 ft. long by 10 ft. wide. Rolled from an age-hardening aluminium alloy, the sheets become progressively harder and stronger if kept at room temperature.

Normally, the slowness of the hardening process permits the sheet to be machined and worked while it is still soft. The sheets in question, however, must be prevented from ageing during the 7-day journey from Iowa to California. To solve this problem, the sheets are packed in dry ice for transport. On arrival at the Long Beach, Calif., plant, the sheets are unloaded from the refrigerated railway wagons and placed in a specially constructed ice-box until the fabricating operations are to be carried out. By maintaining the temperature at 20 deg. F., the aluminium is kept in a suitable condition for stretching.

The sheets are removed from the ice-box as required, placed on a padded layout table, and then trimmed by guiding a Skilsaw equipped with a carbide blade around a full-scale template. A layout of a wing skin on a tapered sheet is shown in Fig. 1.

Next, the dihedral angle is partially preformed by means of a special die on a large hydraulic press brake, as seen in Fig. 2. The panel is transported, and supported during the bending operation, by means of a suspended lifting attachment provided with vacuum chucks.

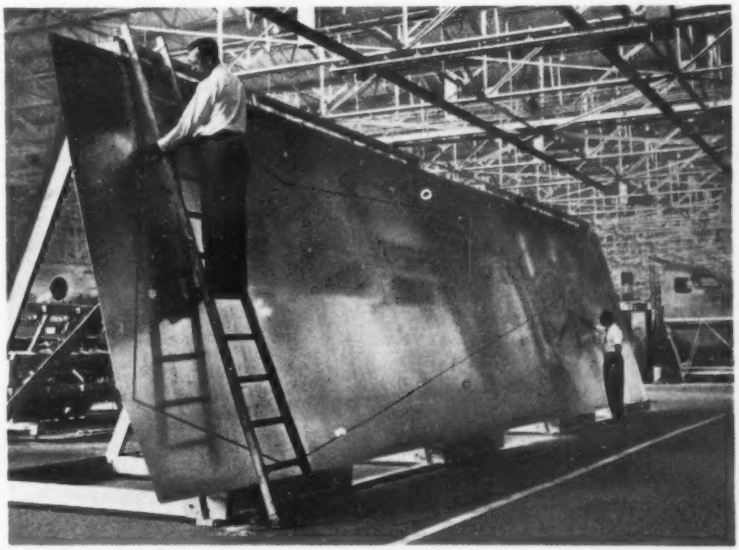


Fig. 1. The Shape of a Wing Skin Panel is Here Laid out on the Longitudinally Tapered Aluminium Plate which is 10 ft. Wide and 46 ft. Long

*Douglas Aircraft Co., Inc., U.S.A.

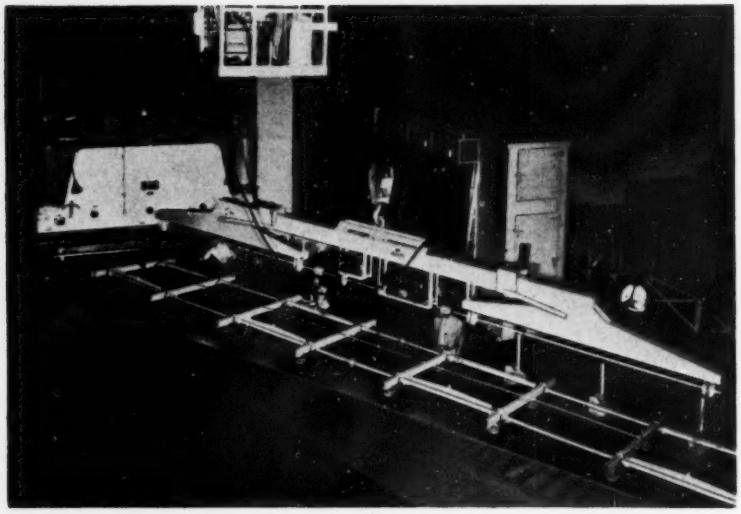
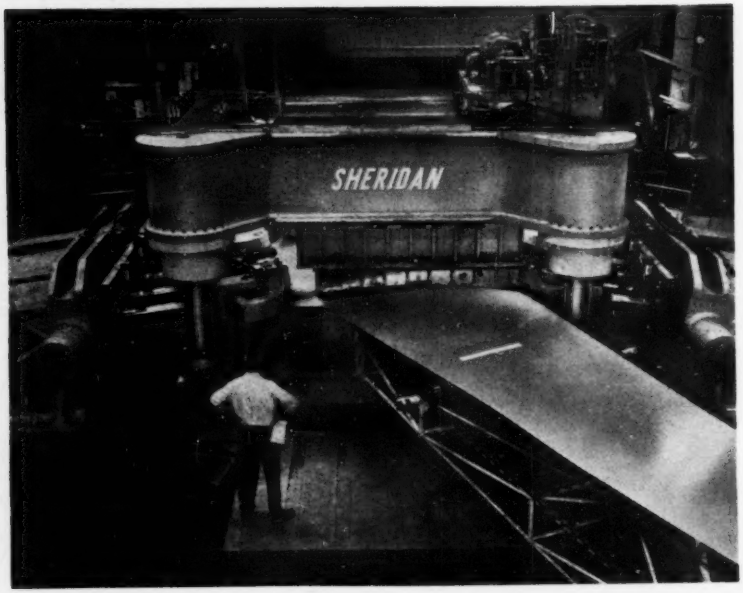


Fig. 2. Prior to Stretching, the Dihedral Angle is Preformed with a Special Die on a Large Hydraulic Press Brake

Fig. 3. (below) Large Press on which the Dihedral Area of the Skin Panel is Stretched. After the Retention Pads have been Applied, the Jaws at Each End Move Back to Stretch the Material



Subsequently, the panel is transferred to the large Sheridan stretching press shown in Fig. 3. This machine weighs 700,000 lb. and it was designed, constructed and installed in a period of 140 days. The press has a 96- by 110-in. die table, which is mounted on a lower ram of 450 tons capacity. A separate overhead unit with four cylinders, each of 600 tons capacity, serves to operate two pads which are employed to restrain the material at the boundaries of the area to be stretched. A pair of jaw units is mounted independently at each end of the die table. These jaws are actuated by eight hydraulic cylinders, each of 150 tons capacity. The rams of two cylinders are connected to each jaw by a clevis, and with this arrangement the angle of pull can be varied. Consequently, the jaws can conform to the dihedral and sweepback angles that are required on the finished panel.

For the stretching operation, the root end of the skin panel is placed over the die and is positioned to match the dihedral angle of both die and panel. A separate die is required to shape each of eight formed wing skin panels for a DC-8. The end of the panel, extending beyond the press, is supported by a lightweight fixture.

The lower, 450-ton ram facilitates raising or lowering the die to the proper position prior to the stretching operation. After the two 300-ton jaw units on each side have been moved in to grip the panel on the forward and aft edges, the two retention pads,

one on each side of the dihedral area, are lowered. With an applied force of 1,200 tons, the panel is effectively sandwiched between the die and the pads, to prevent movement of the material which normally takes place at right angles to the direction of pull during a stretching operation. Finally, tension is applied to the jaw cylinders, and the skin is stretched chord-wise, in the dihedral area, until a permanent set in the material is obtained.

An intercommunications system is provided by five microphone and head-set units, which are worn by the operator and his assistants, to facilitate control of the large stretch press. Upon removal from the press, the panel is finish-trimmed in the area that was gripped by the jaws.

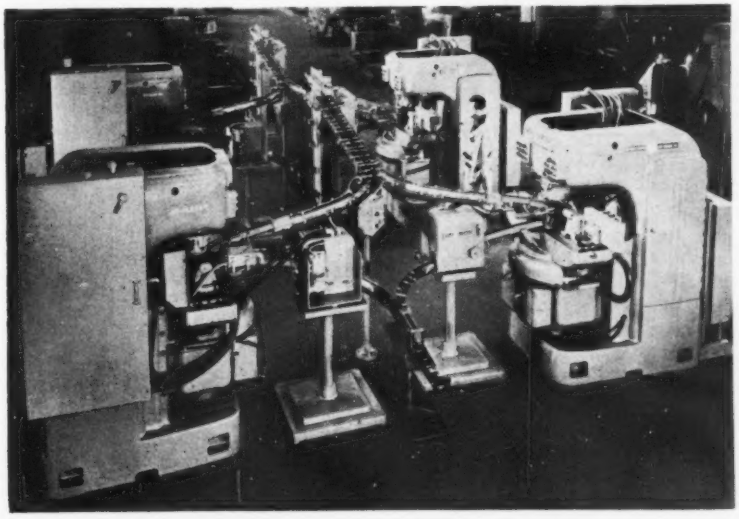
Red Ring Automatic Gear Shaving Installation

An installation of four Red Ring type GCU gear shaving machines, built by the National Broach & Machine Co., Detroit, Michigan, U.S.A., is shown in the accompanying illustration. In conjunction with work handling equipment developed by the company, they provide for shaving, washing and checking 2-step cluster gears on an entirely automatic cycle. The work handling system incorporates curved inclined feed chutes and motorized vertical chain-type conveyors, which enable banks of components to be stored in preparation for shaving.

Each shaving machine is equipped with a Red Ring automatic rocker-type work loading unit, and upon completion of the shaving operation, the gear is passed through washing and automatic inspection units. Any gears which do not pass inspection are automatically rejected. When a predetermined number of reject parts has been produced on a machine, it is automatically stopped, but production continues on the remainder. Each machine, and the associated chain conveyor and inspection unit, can be operated independently by push-buttons to facilitate setting up.

The installation can readily be extended for handling 3-step cluster gears by the addition of another pair of shaving machines, a chain conveyor and feed chute assembly, and motor-driven automatic inspection equipment.

Charles Churchill & Co., Ltd., Coventry Road, Birmingham, 25, represent the National Broach & Machine Co. in this country.



Red Ring Automatic Gear Shaving Installation

SOLVENT FOR EPOXY AND POLYESTER RESINS. A solvent known as De-Solv 292 has been introduced by Oxley Developments Co., Ltd., Ulverston, North Lancs., to facilitate salvaging electronic components from rejected units sealed in epoxy or polyester resin castings. The units are placed in a container with sufficient solvent to cover them, and are allowed to soak for a period of 8 to 12 hours, or longer if the section is unusually thick. Preferably the container should be closed to reduce evaporation losses.

A technique has recently been developed in connection with the use of D-Solv 292, which has been found efficacious in reducing evaporation losses and to eliminate the need to cover large containers of the liquid. With this technique, the De-Solv 292 in the container is covered with a layer of water, about ½ in. deep. Alternatively, a layer of glycerine about ¼ in. deep may be employed. Either liquid substantially decreases solvent evaporation.

Disintegrated resin may be removed from the components by brushing or rubbing and the solvent is reclaimed, for further use, by straining.

Modern Presswork Techniques

By T. G. WOODWARD

In MACHINERY, 92/249—31/1/58, was published an article based on the first part of a paper presented, by Mr. T. G. Woodward, at the annual conference of the Institute of Sheet Metal Engineering, held recently in London. In the first part of his paper, Mr. Woodward considered the use of multi-stage progressive tools for the production of pressings in large quantities, and reviewed the procedure for determining the strip layout and sequence of operations. He discussed the proving of the operation sequence and strip layout with the aid of cheap, experimental, single-stage tools, and described some typical tool-designs. In addition, he considered certain safety arrangements, and the use of compressed air for various purposes, such as ejection and the actuation of stops. This article is concerned with the second part of the paper which was devoted to the production of parts on transfer presses, and the associated tooling.

Many of the points made in connection with multi-stage progressive tools can be applied with equal force to the tooling and operation of transfer presses. The precautions that must be observed in the design of the final component, and the procedures that must be adopted for the determination of blank size and the various stages of development, are generally similar. Design of the actual tools is radically different, however, since many of the features that must be incorporated in multi-stage progressive tools—for example, for the application of top or bottom pressure, ejection or stripping—are included in the normal mechanisms of modern transfer presses. In a multi-stage tool, moreover, the workpieces remain attached to the parent metal and may be controlled by it, to a greater or lesser extent, at the various pressing stages. On a transfer press, however, the workpieces are severed from the strip at the first stage, and are then moved, individually, through the tools for the different operations. In consequence, the tools used on transfer presses are less complex than those of the multi-stage type, and drawing operations are facilitated. In addition, significant material economies can be achieved since the width of stock employed need not allow for the provision of pilot holes nor "webbing" of adequate strength. Furthermore, the large number of tool stations available on transfer presses permits the division of the work between a corresponding number of stages. As a result, the use of expensive and complicated design in order to achieve a given result in a tool of minimum size is avoided, and the tool members are subjected to less pressure and wear.

Transfer presses are of two types. At the present time, the "in-line" press is the more widely employed, and on such machines the workpieces are advanced from station to station, beneath independently adjustable rams, by means of horizontal transfer bars and feeding attachments. The other design of press is the rotary (or dial) type, whereon the workpieces move in a circular path beneath a ram top plate, which is actuated by an underslung crank mechanism in the lower part of the frame, and is guided by four pillars.

PRODUCTION OF A MOTOR CAR NUMBER-PLATE LAMP HOUSING ON AN IN-LINE TRANSFER PRESS

Perspective views of a housing for a motor car rear number-plate lamp are given in Fig. 1. This component is produced on an in-line transfer press, and the sequence of operations is shown diagrammatically in Fig. 2. About 80 per cent

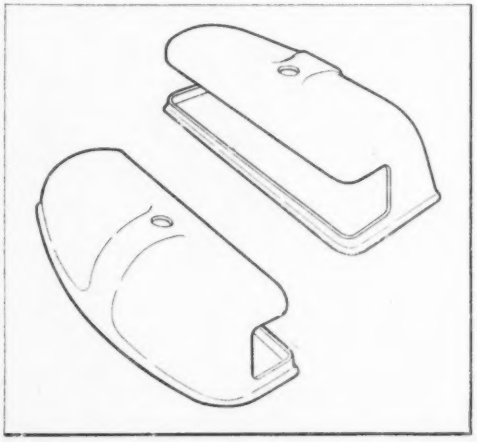


Fig. 1. Perspective Views of a Pressing, for the Rear Number-plate Lamp of a Motor Car, which is Produced on an In-line Transfer Press

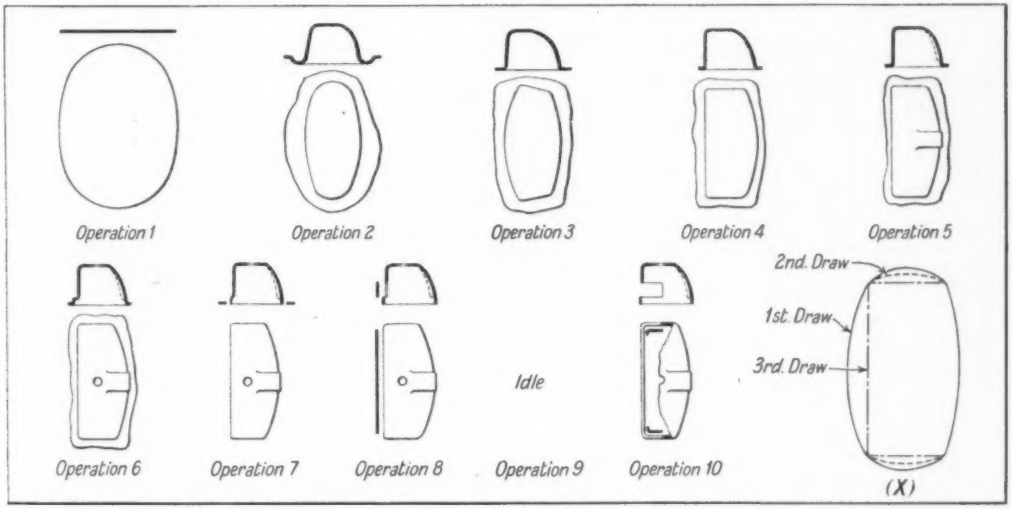


Fig. 2. Stages in the Production of the Pressing, Shown in Fig. 1, are Here Illustrated Diagrammatically. Alterations in the Shape of the Pressing Effected by the Three Drawing Operations are Indicated at *X*

of the operations required for the finished lamp are carried out on the transfer press, the remaining work being performed subsequently, so that one basic type of pressing can be used to produce lamps of different designs.

Work-material in the form of coiled strip is used, and is fed from front to rear, at one end of the press, at 90 deg. to the direction of transfer. The strip passes through straightening rolls before it enters the blanking tool, and in this instance normal, single-row feeding is employed. If desired, the press can readily be arranged for zig-zag, double row feeding, with resulting economies in work-material, when components of certain shapes are being produced.

The shape of the blank is indicated at the first operation stage in Fig. 2. Mounted above the level of the other tool units, the blanking tool is self-contained, and incorporates an annular punch, which is secured to a plate, supported above the lower tool on stacks of Bellville washers. A spring-loaded pusher, fitted to the ram, passes through a hole in the punch plate and through the centre of the annular blanking punch. As each blank is produced, it is thrust by the pusher through the die, and on to a blank-transfer slide below. This slide is positioned at the same height as the main transfer bars of the machine, and it moves in a direction at 90 deg. to the strip, as the ram of the press rises. Each blank, in turn, is carried by the slide to the first of three idle stations, where it is picked up by gripper-jaws attached to the main transfer bars. During successive press cycles, the blank is advanced through the idle stations to the first station at which an operation is performed. The grippers are adjustable, and are set to lift the workpiece slightly, so that it moves from station to station above, and clear of, the lower tools.

At the first working station, the blank is drawn to produce the shape shown in Fig. 2, Op. 2. A tool of fairly conventional design is employed, which is arranged for automatic lubrication of the upper forming members, and pressure is applied to the blank-holder of the lower tool by a pneumatic cushion. At the end of the first drawing stage, the workpiece is ejected from the upper tool and deposited on the surface of the lower tool. Ejection is effected by a top knock-out member, actuated by an adjustable cam incorporated in the press.

After the workpiece has been transferred to the next station, the second drawing stage is performed, to produce a pressing of the shape shown in Fig. 2, Op. 3. The second-draw tool is shown in Fig. 3, and the design is somewhat similar to that of the first-draw tool. The concentric pressure rings *A* and *B* are incorporated in the second-draw tool, however, and the outer ring *A* is thrust upwards by pressure transmitted through pins, from an air cushion below. A flanged ring *A* surrounds an inner ring *B*, which is urged down-

wards by springs. When the upper tool is clear of the lower tool, the two rings *A* and *B* are raised so that their upper faces are flush with the top of the tool base, and an uninterrupted surface is provided which facilitates work-transfer. As the top tool descends, pins *C*, fitted to the top tool, depress the outer ring *A*, against the cushion pressure, and the inner ring can then move down over the fixed punch *D*. As the inner ring descends, the workpiece is drawn over the punch, and the operation continues until the inner ring comes in contact with the flange of the punch. When the upper tool is withdrawn, the outer ring rises, and its flange, in turn, lifts the inner ring, to strip the drawn pressing from the punch, and position it in readiness for pick-up by the transfer gripper-jaws.

The tool for the third drawing stage (Fig. 2, Op. 4) is generally similar, and the changes in the shape of the pressing as a result of the three drawing operations are indicated in the view *X*, Fig. 2. Operation 5 provides for setting the drawn form, also for producing a rib in the pressing, as indicated in Fig. 2. Again, the pressing is supported initially on a pressure pad which surrounds a stationary punch—this time of built-up construction—and the pad is moved downwards, against the thrust exerted by an air cushion, as the upper tool descends.

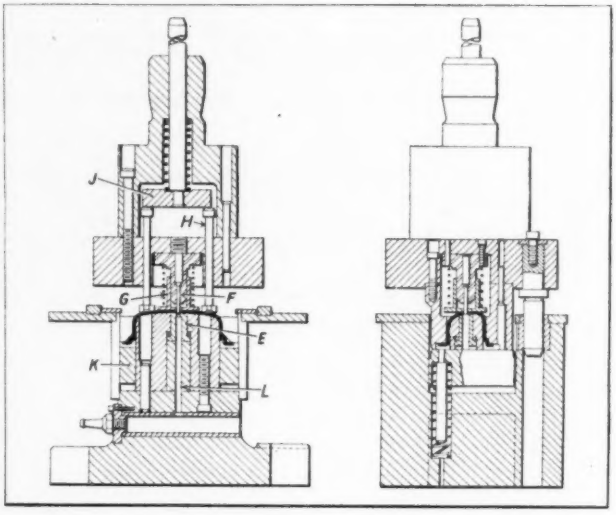


Fig. 4. Sectional Views of the Tool for the Sixth Operation, which Provides for Piercing a Small Circular Hole in the Top of the Workpiece

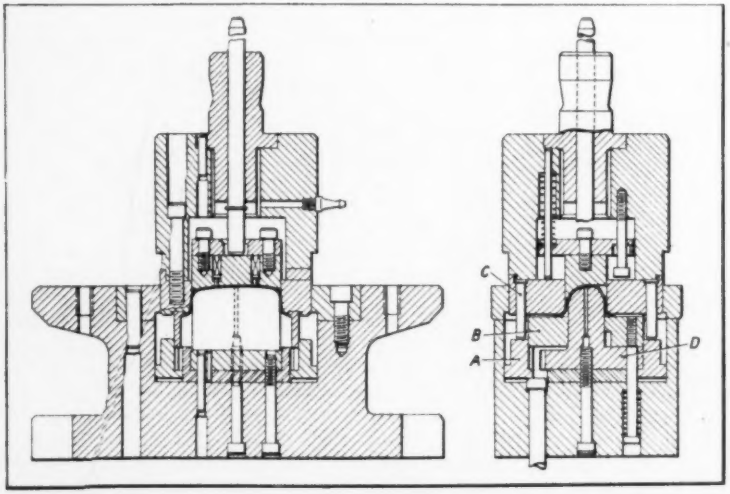


Fig. 3. Sectional Views of the Tool for the Second Drawing Stage. The Pressing is Thrust Downwards into the Lower Tool Assembly, against the Pressure of an Air Cushion

For piercing the small hole, in the top of the drawn form, at the sixth operation stage, the tool shown in Fig. 4 is employed. The die insert *E* is mounted in a formed block in the lower tool, which supports the workpiece during the piercing operation. A replaceable piercing punch *F* is fitted to the upper tool, and the punch holder is surrounded by a flanged stripper bush *G*, which is urged downwards by a powerful spring. On each side of the punch assembly there is a headed pin, as indicated at *H*, and these pins are spanned by a T-piece *J*, which is spring-loaded down-

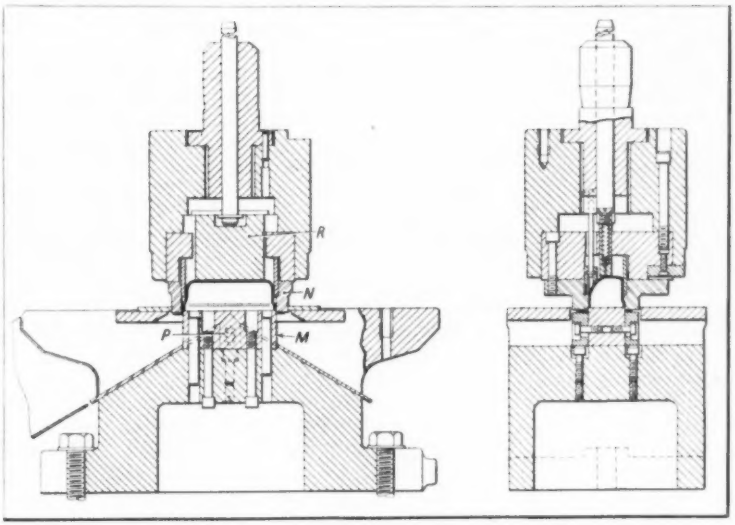


Fig. 5. This Tool is Employed for Operation 7. The Waste Metal Trimmed from the Workpiece is Thrust Downwards and Cut into Two Pieces by Chisel-shaped Blades in the Lower Tool Assembly

wards. After transfer from the preceding station, the workpiece rests on a support plate *K*, and, as the upper tool descends, both the plate and the workpiece are moved downwards by the pins *H*, until the pressing is supported on the formed block in the lower tool. The pressing is held against the block as movement continues, and the punch *F* pierces the hole in its upper face. Slugs from the piercing operation pass down the hole *L*, and into a transverse tube below. They are ejected from this tube by a blast of air, delivered to a nozzle at the left-hand end.

A clipping operation to remove the excess material from the workpiece is performed at the next stage, as indicated in Fig. 2, Op. 7. The tooling for this stage is shown in Fig. 5, and it will be observed that the workpiece remains at the transfer level, whereas at the preceding stages it was moved downwards into the lower tool. After it has been transferred from the piercing tool, the workpiece is deposited by the gripper-jaws above the punch *M*, in the lower tool. The workpiece is accurately located by the clipping die *N*, as the upper tool assembly is moved downwards.

After the waste material has been cut away, it is thrust downwards on to two adjustable chisel-edged blades *P*, which are secured to the clipping punch. These blades sever the waste into two pieces, which fall downwards on either side of the clipping punch, and pass down chutes, clear of the tool area. As the upper tool assembly is

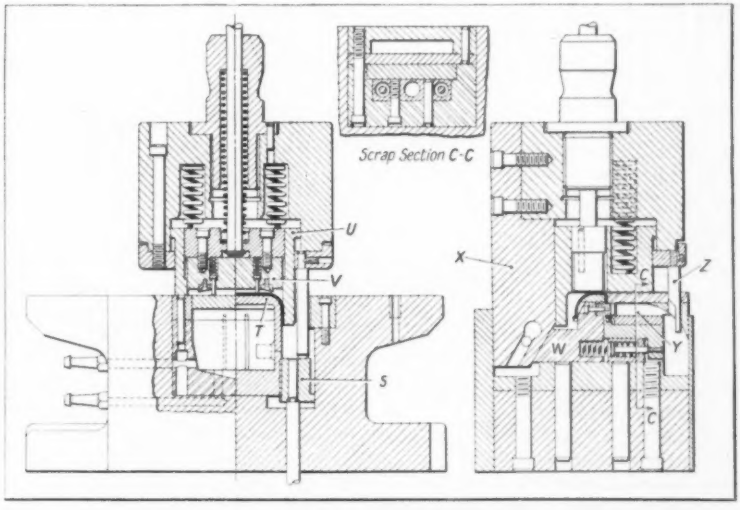


Fig. 6. At the Eighth Operation Stage, this Tool Pierces a Rectangular Opening in the Workpiece. A Punch is Moved Horizontally by Means of a Cam Secured to the Upper Tool Assembly

withdrawn, the workpiece is ejected by the positive knock-out *R*.

The first of the piercing operations, whereby the long, rectangular window is produced, is carried out at the next stage, as indicated in Fig. 2, Op. 8. Sectional views of the tool for this stage are given in Fig. 6. Initially, the pressing is supported on a sliding member *S*, in the lower tool, which is thrust upwards by the action of an air cushion. The member *S* is pushed downwards by pins fitted to the upper tool, as the latter descends, and the workpiece is located accurately, relative to the support block *T* in the lower tool, by the guide *U*, before it is thrust downwards into engagement with this block by the member *V*.

Housed within the support block is a sliding punch carrier *W*. Thrust is applied to an angular face on this carrier by the cam *X*, fitted to the upper tool. In consequence, the punch carrier moves towards the right (as viewed in the right-hand sectional view, Fig. 6), and a rectangular punch pierces the side of the pressing, from the interior outwards. The slug is thrust through an aperture in the built-up die *Y*, and is eventually pushed downwards by a plunger *Z*, attached to the top tool, so that it drops, by way of channels, clear of the tool area. A transverse pin is fitted to the punch carrier *W* and passes through an angularly-disposed slot in the lower end of the cam *X*. As the upper tool is withdrawn, thrust is applied to the pin by the wall of the slot, and the punch carrier is positively withdrawn. Pressure is exerted on the punch carrier by springs, so that, when the cam has been moved clear, the carrier is maintained in a position such that it will readily be engaged by the cam as the upper tool again moves downwards.

No work is done on the pressing at the next station, but, at the following position, notches are cut at each end of the rectangular slot, to complete the piercing of the window, as indicated in Fig. 2, Op. 10. Sectional views of the tool for this operation are given in Fig. 7, where a plan view (partly in section) of the lower tool is also shown. The notches are cut by punches which are mounted at the ends of two arms *A*, pivoted on the lower tool. Die apertures are provided in the block *B* which supports the workpiece. Secured to the upper tool are two pillars *C*, and a cam-form is machined on each pillar. A cam-form is also machined on a third pillar *D*. The arrangement is such that as the upper tool descends, the cam-pillars *C* act on angular faces on the punch-carrying arms *A*, so that the arms are swung inwards, and the punches cut the notches in the workpiece. When the upper tool is withdrawn, the punches are positively retracted by the action of the cam-pillar *D* on a lug that projects inwards from each arm. During the notching operation,

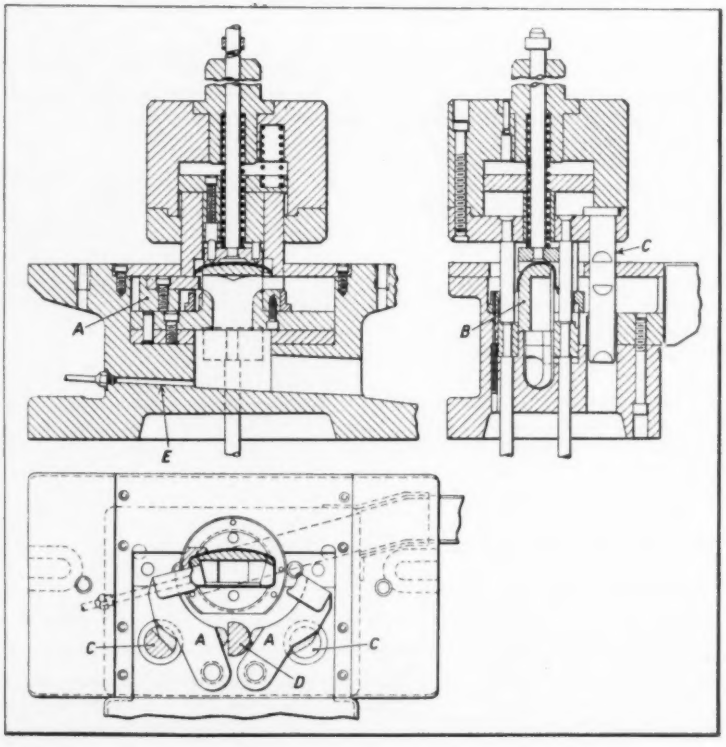


Fig. 7. Piercing of the Large Opening in the Workpiece is Completed by this Tool at the Tenth Operation Stage. Punches Carried on Swinging Arms Cut Notches at Each End of the Previously-pierced Rectangular Slot

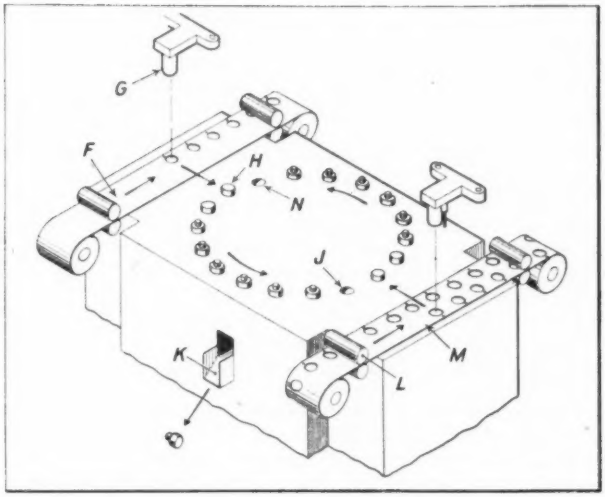


Fig. 8. The Arrangement of a Typical Rotary Transfer Press is Here Shown Diagrammatically. The Machine is Arranged for the Production of Two Workpieces Simultaneously, from Blanks that are Cut and Delivered from Each Side

the workpiece is held on the die block by a spring-loaded plunger in the upper tool, and, when notching has been completed, it is stripped from the die block by means of a sliding support plate, which is connected to a pneumatic cushion. Slugs from the notching operation pass downwards, through channels in the die block, into a cavity in the tool base, and are blown clear of the tool by an air blast delivered to the hole *E*.

ROTARY TRANSFER PRESSES

On a rotary transfer press, the tooling stations are positioned on the circumference of a circle, and a typical layout is shown diagrammatically in Fig. 8. In this instance, the press is arranged for the production of two workpieces simultaneously, and is equipped with two feed units. Strip is first passed through the roll feed mechanism at one side of the press, as indicated at *F*, and blanks are produced by the action of the punch *G* and its associated die (not shown). The blank, thus produced, is transferred sideways to the adjacent tool *H* at one of the circumferentially-disposed stations. It is moved from stage to stage, through these stations, in an anti-clockwise direction (as viewed from above), until it reaches the position *J*. Here, it is thrust through the lower tool into a chute *K*, whereby it is delivered to a suitable receptacle. When blanks have been cut from a complete coil of stock, the coil is transferred to the roll feed unit *L* at the opposite side of the press, where a second row of blanks is cut, which are staggered relative to those of the first row, as indicated at *M*. Each blank is transferred sideways to one of the circumferentially-disposed stations, and is then moved in an anti-clockwise direction until it reaches the station *N*, where it is thrust through the lower tool into a chute, whence it passes into a workpan.

The transfer mechanism, for moving the workpiece from stage to stage, is operated from a central pillar, and the gripper fingers are actuated by a spring-loaded cylinder and controlled by a central cam, attached to the ram of the press. Provision is made for fitting special-purpose equipment, to provide for spinning, rolling, rotary cutting, or turning the workpiece through any desired angle.

All transfer fingers are of similar design, and since they are suitable for any diameter of workpiece, within the press capacity, do not need to be changed for different pressings. A safety arrange-

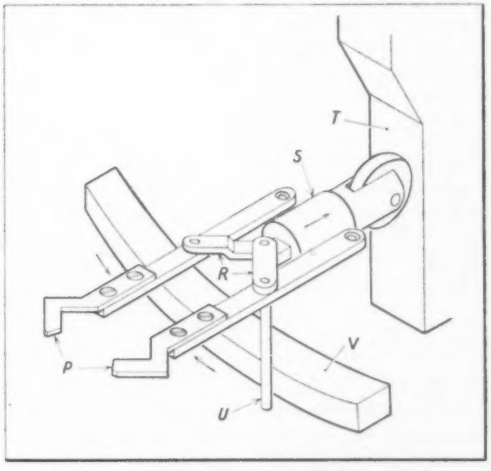


Fig. 9. Perspective View of the Gripper Fingers on a Rotary Transfer Press. If the Fingers do not Grip the Workpiece, and thus Close Beyond a Pre-set Position, the Press is Stopped

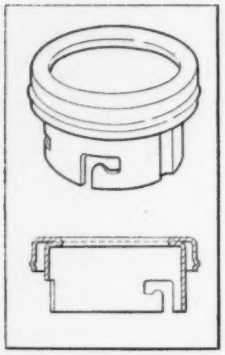


Fig. 10. This Lamp-holder is Produced in 14 Working Stages on a Rotary Transfer Press

ment is incorporated which is interlocked with the pneumatic clutch and stops the press if the fingers do not close properly. This arrangement is shown diagrammatically in Fig. 9. The fingers *P* are opened and closed by means of the links *R*, which are coupled to a follower *S*, actuated by a cam *T*. The pivot pin connecting the links to the follower is extended downwards, as indicated at *U*. If the fingers do not grip the workpiece—for example, if the pressing has not been ejected from the lower unit of a drawing tool—the pin *U* moves through a greater distance than normal towards the centre of the press and contact is made with the ring *V*. Through associated switchgear, the electrical control circuit for the clutch is then broken, and the press is stopped.

Some operational features of rotary transfer presses may be explained by considering the production of a lamp-holder, perspective and sectional views of which are shown in Fig. 10. This workpiece is produced at a rate of 40 per min., from mild steel coiled strip, 0·028 in. thick, and the sequence of operations is shown diagrammatically in Fig. 11. Work-material passes from the coil on a holder at the front of the press, through a double set of feed rolls, and is advanced at a height of approximately 2 in. above the blank-and-raise tool for the first operation stage. This tool is located in a position corresponding to that of the blanking tool *G*, Fig. 8.

The work-material is fed, and the raised blank is transferred to the first of the circumferentially-disposed station, by means of the mechanism shown in Fig. 12. After it has passed through the first pair of feed-rolls *A*, the strip is taken through the hinged guides *B* and *C*, which support it above the lower members of the blank-and-raise tool. Waste material passes, through the feed rolls *D*, to a power-driven coiling unit (not shown). During each cycle of the press, the guides *B* and *C* are swung downwards, and the strip is lowered on to the face of the blanking die, before the upper tool descends to cut and raise the blank. As the upper tool rises, the workpiece is ejected from the die, and is supported on the surface of the lower tool, the strip being lifted to its original position. Next, two fingers *E* are swung inwards to grip the workpiece, and the rams carrying the fingers are advanced so that the workpiece is brought to the first of the circumferentially-disposed stations, *F*, where it is deposited on a spring-loaded platform. The fingers are then opened, and the rams are returned in readiness for the next cycle.

No work is performed on the pressing at station 1, and the workpiece remains on the spring-loaded platform until the next cycle of the press, when gripper fingers, positioned on either side, move inwards to grip the piece and transfer it to station 2. At this station, a drawing opera-

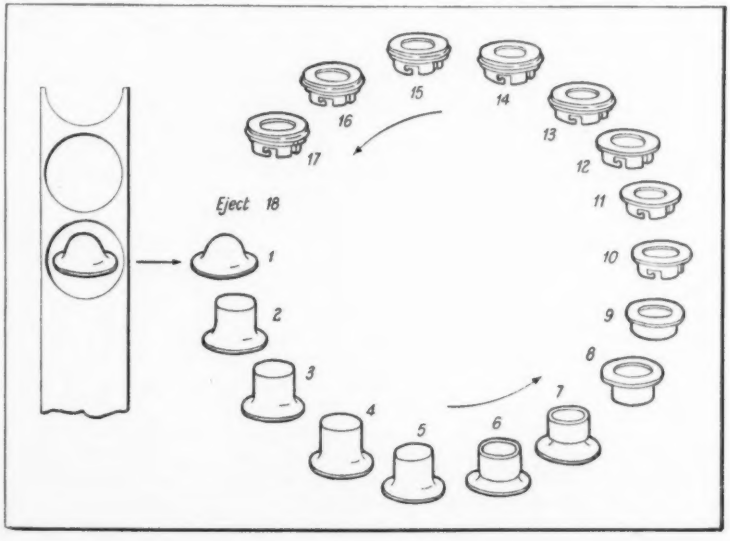


Fig. 11. The Stages in the Production of the Lampholder, Fig. 10, are Here Shown Diagrammatically. There are Three Idle Stations, and One Station Each for Inverting and Ejection

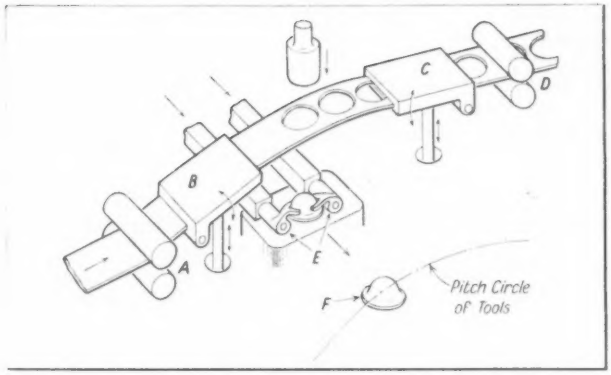


Fig. 12. The Arrangements for Feeding the Strip, and Transferring the Raised Blank to the First of the Circumferential Stations of the Rotary Transfer Press

tion is performed, and at the next stage (number 3) the drawn form is "set." The fourth station is idle, and at the fifth station, a rotary-trimming operation is performed with the aid of a motor-driven unit. When the workpiece is released by the fingers at the fifth station, it rests on a spring-loaded pommel, which is thrust downwards, to a position controlled by a stop, by a heavily-loaded spring pressure pad, as the upper tool members descend. A revolving cutter is then advanced by a mechanical linkage, and when the cutter makes contact with the workpiece, the latter rotates with it, and the closed end is cut away. The scrap material is removed from the face of the pommel by a blast of air, and falls away through an aperture in the side of the machine base.

Forming of the workpiece neck is carried out at stations 6 and 7, by means of a single motor-driven roll, located between the two stations, outside the ring of tools. Provision is made for adjusting the roll radially, and locating pommels are secured to the ram of the press. The diameter of each pommel is reduced at the lower end to the size required for each rolling stage, and as the ram of the press moves downwards, the pommel enters the workpiece, until it makes contact with a lower pommel. At this stage, the motorized roll unit is advanced, to complete the two forming stages on the neck.

After the second rolling operation, it is necessary to invert the workpiece, in order that a series of operations on the smaller end may be performed. An attachment mounted at the side of station 8, incorporates spring-loaded jaws, which are positioned so that they accept the workpiece after it has been transferred by the main gripper fingers. After the fingers have opened, the jaws, and with them the workpiece, are turned through 180 deg., and the workpiece is picked up by gripper fingers at the next transfer stage, and transported to station 9, where the flange is planished.

The planishing tool is shown at the left in Fig. 13, and it will be seen that the lower tool members are housed in a base which is common to the next tool for piercing the bayonet slots and forming a location rib. A central spring-loaded pressure pad is provided for each stage of the upper tool, and these pads ensure that the workpiece is located correctly, and that it remains in the lower

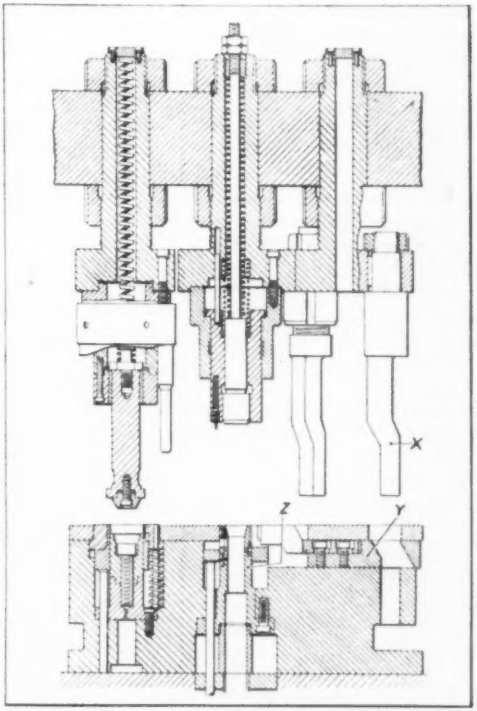


Fig. 13. The Tooling for Operations 9 and 10 in the Production of the Lampholder, Fig. 10. Horizontally-moving Punches, Actuated by Dog-leg Cams, are Provided for Cutting the Bayonet Slots and Forming a Location Rib

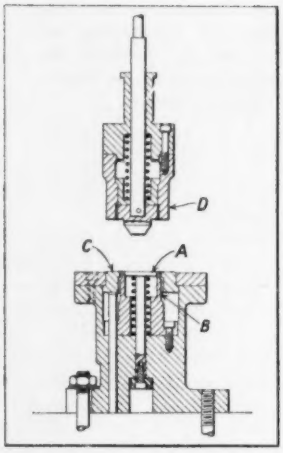


Fig. 14. This Tool Unit is Provided for Operation 13, at which the First Stage in the Formation of the Circumferential Bead on the Lampholder is Carried Out

tool when the upper tool rises. The horizontally-moving punches at station 10, which pierce the bayonet slots and form the rib, are actuated by dog-leg cams, as indicated at *X*. This cam serves to move the slide *Y*, which carries the forming punch. Slugs produced by the bayonet slot punches pass through the die aperture, and drop through the tubular work-support *Z*, and the table of the press, into a pan below.

An idle station follows, and at station 12 a clipping operation is performed. The first of the operations for forming the bead is carried out at station 13, and the tool-assembly for this stage is shown in Fig. 14. It will be seen that the assembly is of simple construction—as are most of the other tools on the press—and that the workpiece is located initially by a spring-loaded plunger in the upper tool. As the upper tool descends, the pressing is thrust downwards against the pressure exerted on its lower end by a spring-loaded pad *A*, and is finally located within the punch *B*, with its flange supported on the pressure ring *C*. During further downward movement of the upper tool, the flange is drawn downwards over the punch, by the action of the tubular drawing die *D*, the shape of the workpiece after this operation stage being indicated in Fig. 11.

The second operation for forming the bead is carried out at station 14, and the bead is finally set to the shape indicated in Fig. 10 by a tool at station 15. Tools at stations 16 and 17 provide for setting the bottom of the pressing and gimping the flange in line with the location rib, and the finished pressing is finally transported by the transfer fingers to station 18, where it is released to fall through the base of the machine into a work-pan.

In conclusion, the importance of good collaboration between the designers and users of power presses, of all types cannot be stressed too forcibly. Apart from an intimate knowledge of the functioning and capacities of their various machines, designers should be able to provide information based on a wide background of experience of the application of their presses. Press users, on the other hand, should be able to specify their needs, in the light of advances in pressing techniques, and have experience of producing similar pressings and the tooling necessary. They should also be aware of any special requirements for a particular component, either during the pressing sequence, or during subsequent stages of manufacture or assembly.

The author acknowledges, with gratitude, permission of the directors of Joseph Lucas (Electrical), Ltd., to use data and illustrations included in his paper.

"SERSEAL" LAYER PROCESS FOR METAL TREATMENT BATHS. The Paints Division of Imperial Chemical Industries, Ltd., Imperial Chemical House, Millbank, London, S.W.1, has introduced the "Serseal" layer process—which is the subject of a British patent application—for eliminating fumes and steam from aqueous metal treatment baths, and for reducing heating costs. This process seals the surface of the processing liquid with a layer of inert material, which not only checks fumes and steam but reduces the amount of heat required to keep the bath at a working temperature, so that fuel economies up to 75 per cent have been obtained.

Because the Serseal eliminates steam and condensation, it is often possible to dispense with exhausting equipment. Working conditions are improved and shop condensation and structural corrosion are retarded.

The process can be operated without alteration to the processing tank, and it is claimed that because heating requirements are reduced, heating units need less frequent cleaning, so that maintenance costs are reduced.

Serseal was developed primarily for use in baths for producing heavy phosphate coatings, such as those employed in the I.C.I. Granodine 101 process, but its application has now been extended to other Granodine processes. Certain precautions are, however, necessary where work is to be subsequently painted. Other grades of Serseal can be supplied for suppressing acid fumes and spray from pickling tanks, and conserving heat in alkaline paint stripping vats.

New Production Equipment

Craven 90-in. Precision Gear Hobbing Machine

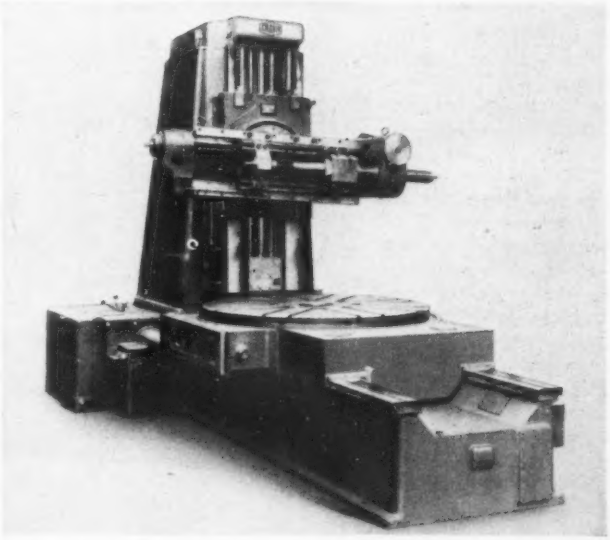
Craven Brothers (Manchester), Ltd., Reddish, Stockport, have recently built the 90-in. precision gear hobbing machine shown in the figure, for the Empresa Nacional "Bazan" de C.N.M., S.A., Madrid, Spain. Although it will be principally employed for the production of gears of commercial quality, it may sometimes be required to cut extremely accurate turbine reduction gears, and the machine has been built, therefore, in accordance with the limits of inaccuracy laid down in the British Standard specification for Grade A hobbing machines for turbine drives.

Gears up to 90 in. diameter and a maximum face width—for spur gears only—of 34 in. can be accommodated. The maximum pitch which can be cut is 1 D.P. or 25 module, and the maximum helix angle, 30 deg. Preliminary roughing operations are recommended for gears of the larger pitches. Straight spur and helical gears can be hobbed with vertical feed, and worm gears can be cut either with fly-cutters or taper hobs by applying a tangential feed movement to the hob-slide. Alternatively, worm gears can be cut with a parallel hob, and "sinking-in" feed applied to the table. In addition, spur and helical teeth can be milled singly, by using a disc-type cutter with vertical feed, provision being made for hand-indexing with a "single-notch" plate. The latter enables all numbers of teeth up to 600 to be obtained. This procedure facilitates roughing-out large-pitch gears, preparatory to hobbing.

To meet the customer's requirements, the machine, which is of the moving table, fixed column type, is so arranged that all these operations can be performed with a single, swivelling-type hob-slide. This slide has a tangential traverse of 18 in., and can be used at any swivel position. Compliance with this condition has inevitably restricted the face widths that can be covered when cutting helical gears, since these widths depend on the hob-slide setting and the centre distance between the hob and the gear blank.

The nut for the hob-slide feed screw has adjustment for taking up backlash, and the hob-slide is positively overbalanced so that the climb-hobbing method can be employed, if desired. Taper bronze bearings, with adjustment for wear, are provided for the hob-spindle, and the maximum diameter of hob or fly-cutter that can be employed and the minimum hob root diameter, are 10 and 5 in., respectively. The hob-slide has a maximum vertical traverse of 39 in.

Designed to carry loads up to 10 tons, the 72-in. diameter table is T-slotted to receive work fixtures and arbor brackets. It rotates on flat tracks, and has a large-diameter, cylindrical spindle



Craven 90-in. Precision Gear Hobbing Machine

which is lapped into its bearing with minimum running clearance. A 70-in. pitch-diameter master wheel is secured to the under-side of the table, and is driven by a dual-lead worm so designed that all backlash can be eliminated by axial adjustment, without affecting the uniformity of the motion transmitted.

The normal maximum and minimum centre distances between the hob and the table are 50½ and 9½ in., respectively, but by using a packing-piece provided for the hob-slide, the latter dimension can be reduced to 3 in.

A substantial column, which can be mounted upon the table saddle, when cutting the smaller gears, carries a balanced arm for supporting the upper end of the work arbor. The arm has vertical, hand adjustment on the column, and is so constructed that it can be swivelled outwards in halves to facilitate loading. Gears up to 48 in. diameter can be accommodated with the column in position.

Drive is taken from a 10-h.p. constant-speed motor, through pick-off change gears, which provide a range of hob speeds from 12½ to 100 r.p.m. A totally-enclosed gearbox houses all the mechanism for the various machine motions, comprising the dividing, spiralling and feed gears, also the gears for obtaining prime numbers. Two differential units are included, one for spiralling when cutting helical gears and the other for prime numbers. All numbers of teeth from 20 to 600 can be cut without special change wheels, and at any speed, feed or angle within the capacity of the machine. The design of this machine is such that two levers provide for the selection of all the alternative motions.

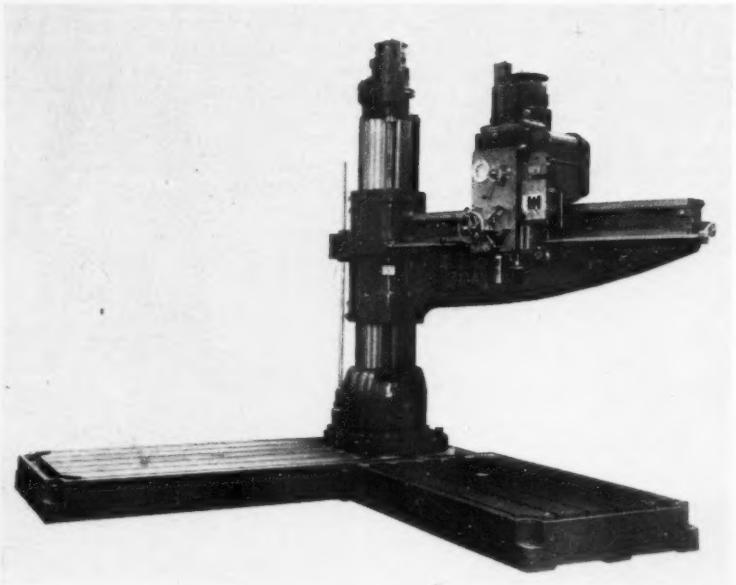
Feed and rapid power traverse motions are available for the hob-slide, vertically and tangentially, and for the table longitudinally on the bed. Feed rates are in inches per rev. of the gear, for use when hobbing spur, helical or worm gears, or in inches per rev. of the cutter for milling. Adjustable electrical trips limit the travel both for feed and rapid traverse motions, and the feeds can be started, stopped or reversed without affecting the relative positions of the hob and the teeth being cut. Rapid power rotation is provided for the work table, for setting purposes.

A single motor-driven pump unit and reservoir supply filtered oil to all the gears and bearings in the gearbox, bed and column, and, by flexible hose, to the hob-slide for the spindle driving gears and bearings. A separate mechanically-operated pump automatically lubricates the table spindle bearing, and the tracks and driving worm are always partially or totally immersed in oil. Electrical interlocks ensure that the machine cannot be started unless the main oil supply is circulating. Coolant is supplied to the point of cutting by a separate motor-driven pump unit from a reservoir in the bed.

Town 8-ft. Radial Drilling Machine

The accompanying illustration shows an 8-ft., centralized control, radial drilling, boring, tapping and studding machine, the largest in the new C.E.2 range, which has recently been built by Fredk. Town & Sons, Ltd., Mile Cross Works, Halifax, and supplied to Glenfield & Kennedy, Ltd., Kilmarnock, Scotland.

This machine is capable of drilling up to 3 in.



Town 8-ft. Radial Drilling Machine

diameter from the solid in mild steel, and 3½ in. diameter in cast iron, and will tap Whitworth threads up to 2 in. diameter in mild steel.

A 2-way, T-slotted baseplate has holes to receive steady bushes for boring bars, and a sump for cutting lubricant is provided beneath the pillar. Each section of the baseplate has a working surface of 8 ft. 1 in. by 4 ft. 3 in., and is 9 in. deep.

The sleeve carrying the radial arm is of 20 in. diameter, and is carried on ball bearings on the pillar, so that it can readily be rotated through a full circle. A combined locking arrangement, operated by a lever on the saddle, secures the sleeve to the pillar and the saddle to the arm.

A wide top guide is provided for the saddle, and the arm has a long bearing on the sleeve. Vertical power adjustment is provided for the arm, the drive being taken from a 3 h.p. motor through gearing running in an oil bath at the top of the pillar. There is a safety device to prevent over-running, and a tell-tale nut is fitted to the elevating screw. The arm has a movement of 2 ft. 9 in., and the maximum and minimum distances from the spindle to the baseplate are 6 ft. and 21 in.

Of box form, the saddle has a movement of 6 ft. 3½ in., and is traversed on ball bearing rollers, by handwheel, through a pinion and steel rack. Drive to the spindle is taken from a 7½ h.p., vertical, constant-speed, non-reversing motor, mounted on top of the saddle, through worm gearing, multi-plate friction clutches and gearbox. The motor is started, stopped and reversed by means of a lever on the saddle.

Of forged high-tensile steel, the 6-splined spindle has a 2¼-in. diameter driving portion, and is carried in a hardened steel sleeve which ensures full support over the total traverse of 18 in. End pressure is taken on ball thrust bearings, and the spindle and sleeve are balanced by a compensating spring arrangement. The feed rack is cut in the sleeve and is engaged by a steel pinion. Bored No. 5 Morse taper, the spindle has a cotter hole for mounting tapping attachments.

Hardened, nickel-chrome steel gears provide 18 spindle speeds, ranging from 15 to 850 r.p.m. Changes are obtained by means of two levers, and direct-reading plates show the correct speeds and feeds for different diameters of holes when drilling mild steel or cast iron. A pump in the saddle supplies lubricant to all working parts.

Eight rates of feed, from 0·02 to 0·004 in. per rev., selected by two levers on the saddle, can be used with any spindle speed. Power feed is engaged or disengaged by a slight push or pull on the cross-handle at the front of the saddle, and this handle also provides for rapid hand movement when the automatic feed is not in use. An automatic depth stop is provided, and safety trips disengage the power movement at the top and bottom of the spindle traverse. For fine hand feed, there is a handwheel at the bottom of the saddle.

The maximum height from the floor to the top of the saddle motor is 12 ft. 1 in.

Sciaky Resistance Welder for Experimental Work

The type UAM.150 resistance welder, here shown, has recently been introduced by Sciaky Electric Welding Machines, Ltd., Falmouth Road

Sciaky Resistance Welder for Experimental Work

(Trading Estate), Slough, Bucks., primarily for carrying out experimental spot, seam, roll-spot and projection welding. If required, it can also be used for production work.

Two brackets are arranged to swivel on support bars at the sides of the fabricated steel frame, and can readily be swung to the working position, to bring different lower electrodes into use, for performing various welding operations. Whichever bracket is not in use is swung to a position at the side of the frame so that it is clear of the working area.

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The bracket mounted on the right-hand support bar carries a circular electrode for seam or roll-spot welding, and when it is set in the working position, as shown, the electrode spindle engages with the output shaft of a variable-speed motor, which is provided with a brake. A T-slotted platen for projection welding is secured to the other bracket, and, when required, an electrode for spot welding can be fitted. Upper electrodes for spot, seam and roll-spot welding can readily be mounted on the pressure head, which carries a platen for projection welding.

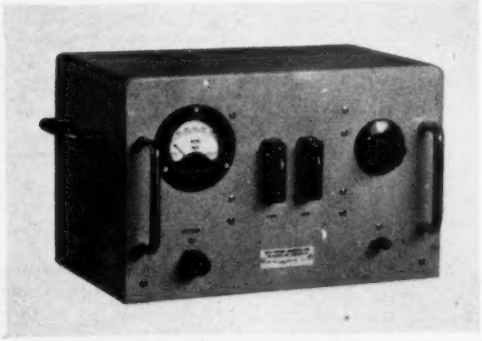
Mounted in rollers, the head is operated by a diaphragm-type air cylinder, and provision is made for a single-, two-, or three-pressure cycle. A tool is provided for knurling the edges of circular electrodes when seam welding is to be carried out on coated metals.

Housed in a separate floor-mounted cabinet at the side of the machine, the Sciaky electronic control equipment enables the welding period to be varied accurately down to ½ cycle, and provides for phase-shift, stepless heat adjustment, slope control, and pre-heating and post-weld heating of the work. Three, fully synchronous, dekatron counters, of the company's design, are incorporated, which in conjunction with the variable-speed electrode driving motor, enable a wide variety of settings to be obtained.

The machine is available with nominal ratings from 150 to 750 kVA.

Selig Speed Controller for D.C. Fractional Horse-power Electric Motors

For controlling the speeds of direct-current f.h.p. motors, Selig Electro-Magnetics, Ltd., 296 Kilburn Lane, London, W.10, have introduced a unit of the magnetic-amplifier type. The standard equipment, for use with $\frac{1}{10}$-h.p. motors, is shown in the accompanying illustration.



Selig Speed Controller for D.C. Fractional Horse-power Electric Motors

This controller operates on an A.C. supply of 230/240 volts and is connected to the D.C. motor by a 4-core cable. Speeds are varied by rotation of the large-diameter dial at the right-hand end of the control panel. In addition, provision can be made for control by a pedal, or by a remotely-situated potentiometer. The control panel also incorporates a combined "on-off" and reversing switch, and a knob for adjusting feed-back current. This knob has three positions, and enables almost constant speed/torque characteristics to be obtained throughout the 25:1 speed range. Speeds are indicated by a differential milliammeter, the dial of which is calibrated in r.p.m. With this instrument, readings are obtained in accordance with the armature voltage and armature reaction, which varies with the load.

No valves are employed in the circuit, which is protected by fuses, and the controller can thus be brought into use without any "warming up" period. The stove-enamelled case occupies a space of 14 by 9 by 9 in., and the weight of the unit is 40 lb.

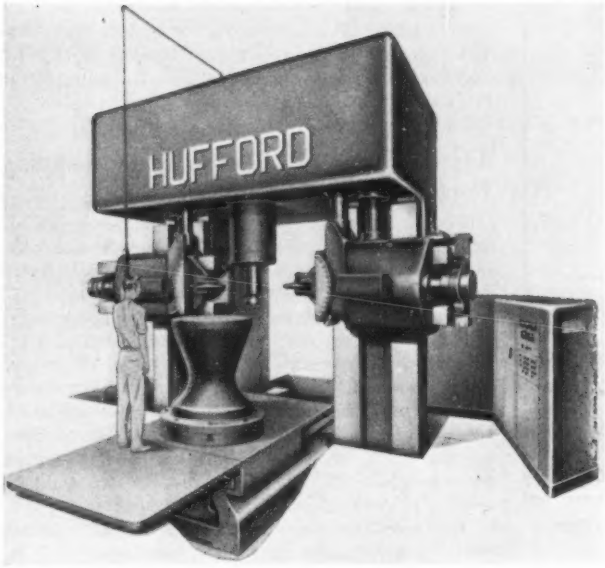
Hufford Vertical Spinning and Forming Machine

Known as the Spin Forge, the vertical spinning and forming machine, here shown, has been built by the Hufford Corporation, El Segundo, Calif., U.S.A. It enables parts of parabolic, hemispherical, and conical shapes, for example, to be produced with wall thicknesses that can be varied from about 1 in. down to a few thousandths.

The sheet-metal blank is formed over an upright revolving die by two horizontally-opposed rolls, which are traversed downwards, and follow the die contour under the control of templates and tracers at the rate of 60 in. per min. These rolls are mounted on tilting heads, so that they are maintained at right angles to the die surface during the operating cycle, and they are applied to the work with a load of 100 tons by hydraulic cylinders operating at a pressure of 3,000 lb. per sq. in.

A rotary table, which carries the die, is mounted on a slide so that it can be brought clear of the working area for loading and unloading. Drive to the table is taken from a 200-h.p. motor, and speeds up to 400 r.p.m. are provided.

To enable the work to be closely observed, with safety, while the machine is in operation, a closed-circuit television system, with two Hallamore cameras and screens, is provided.



Hufford Vertical Spinning and Forming Machine

Hufford sheet-metal forming machines are distributed in this country by Wickman, Ltd., Fletchamstead Highway, Coventry.

Everac Hydraulically-released Diaphragm Chuck

In Fig. 1 is shown the Everac hydraulically-released diaphragm chuck which has recently been placed on the market by Integral, Ltd., Birmingham Road, Wolverhampton. The subject of a patent application, this chuck is available in various forms, and Fig. 2 is a sectional view of one type.

The diaphragm *A* is attached to the body, and its reduced-diameter right-hand end is bored and slotted to form six segments, which are normally fitted with three or six jaw pieces for holding the work. Alternatively, for long runs, diaphragms with chucking rings ground to suit particular components may be employed, and separate jaw pieces are not then required. The jaw pieces are ground to the same diameter as the workpiece, while the jaws are held open by a known amount with the aid of a setting ring. Thus, the jaw pieces are ground at the setting they will assume when actually holding the work, and although the diaphragm is not subjected to hydraulic pressure, it is under strain. In consequence, when the work is held, the diaphragm *A* is slightly deflected so that gripping pressure is applied by spring action. There is then a small clearance between the raised central portion on the diaphragm *A*, and a similar portion on the diaphragm *B*, which is also secured to the body.

A space between the left-hand side of the diaphragm *B* and the body, is filled with fluid, and communicates with a central bore which houses the piston *C*. To release the workpiece, the piston *C* is moved to the right, and the resulting pressure applied to the diaphragm *B* causes this member, and the diaphragm *A*, to be deflected, so that the jaws are opened. A load of only 12 lb. need be applied to the piston for releasing the work, and a travel of 0·450 in. gives a movement of the jaws of 0·003 in. on diameter. When a chuck of this design is employed on a lathe, for example, the piston *C* can be operated by a push rod which is arranged to slide in the headstock-spindle bore.

In another design, the piston extends radially through a cross hole in the body and is depressed by hand for deflecting the diaphragms when the

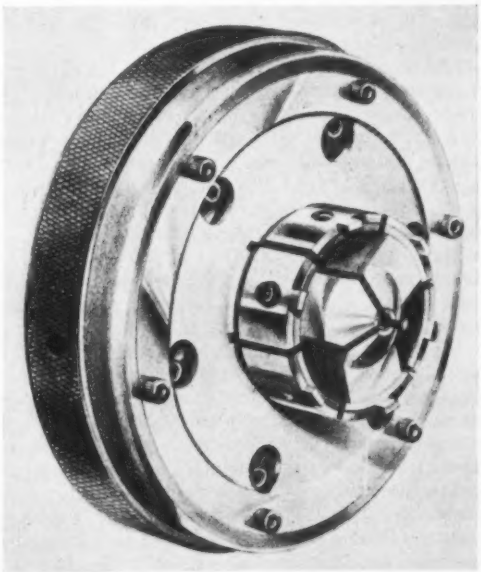


Fig. 1. Everac Hydraulically-released Diaphragm Chuck

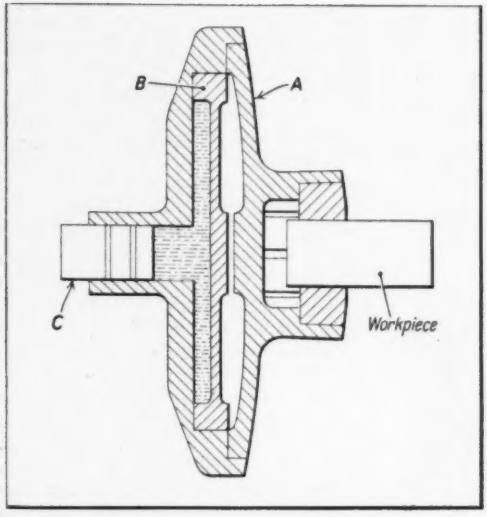


Fig. 2. Diagrammatic Sectional View of One Type of Everac Diaphragm Chuck

work is to be released. The chuck shown in Fig. 1 incorporates three radially-extending pistons, which are operated by a knurled ring-shaped cam surrounding the body. With the arrangements here described, the risk of accidental release of the work is virtually eliminated, and the use of rotating oil seals and pipes is avoided.

Chucks of the type shown in Fig. 1 and 2 are at present available with a 2¼-in. diameter by 0·6-in. deep bore for accommodating the three or six jaw pieces. The chuck with cam-operated pistons has a maximum diameter of 7 in., and the overall length is 2⅛ in. A backplate with a central bore is provided for mounting the chuck on a machine spindle. The chuck shown in Fig. 2 has a 6⅝-in. diameter body, which is provided, at the rear, with a 3 1/16-in. diameter register. On both chucks, the segments have an external diameter of 2⅜ in. and a length of 1⅛ in.

With the aid of standard setting rings, the jaw pieces or segments can be ground to different diameters, for a particular workpiece, to provide various gripping pressures up to 2¼ tons. It is stated that when jaw pieces with precision ground contact surfaces are removed from the segments and subsequently replaced, an accuracy for concentricity within 0·0002 in. is obtained. If greater accuracy is required, the gripping surfaces may be reground with the jaws assembled in the chuck.

It is planned to extend the range of chucks to include others of different sizes, which will be available with central bores arranged to take long workpieces. Equipment for remote operation is being developed, which will enable the chucks to be employed on machines with fully-automatic working cycles.

Agathon Type 125-S Grinding and Lapping Machine for Carbide Tools

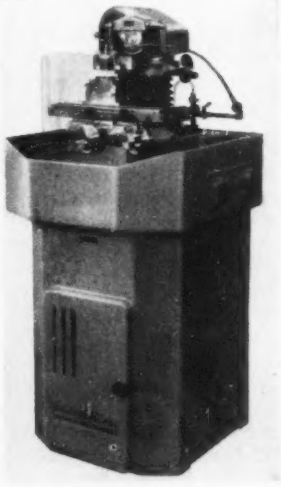
The accompanying figure shows the type 125-S grinding and lapping machine for tungsten-carbide cutting tools, recently introduced by the Swiss firm of Agathon.

Mounted in precision plain bearings, the spindle will take diamond-impregnated wheels up to 5 in. diameter, and may be driven, in either direction, at a speed of 3,500 r.p.m., by a ¾-h.p. motor. Vertical rapid adjustment of the swivel wheel-head, through a maximum distance of 6 in., is effected by a 0·1 h.p. motor, fine settings being obtained by a handwheel. Scales are provided to facilitate setting the wheel-head for height and angle.

Backlash-free movement of the swivelling work table is obtainable through a distance of 4 in. longitudinally, and there is a cross adjustment of 2⅜ in. Adjustable stops are provided on the table for positioning the tool in relation to the wheel for grinding chip breaker grooves. The work holder mounted on the table has a lever-operated clamp for gripping cutting tools with shanks up to 3 in. thick. It can be swivelled in the horizontal plane, and tilted in both directions on each side of the central position. Motor-driven coolant equipment and splash guards of transparent plastics material are provided.

The machine occupies a floor space of 27½ by 27½ in., and weighs approximately 7 cwt.

Agathon grinding and lapping machines for tungsten-carbide tools are handled in this country by the Tornos Sales Co., Broadgate House, Coventry.



Agathon Type 125-S Grinding and Lapping Machine for Carbide Tools

E.I.A. Group Apprenticeship Training Scheme

By K. M. WARD, M.A. (Cantab.), A.M.I.E.E., A.M.I.Prod.E.

In the past, the limited range of manufacturing processes undertaken by any one small or specialist firm has often prevented such an organization from accepting apprentices for comprehensive training. However, the increasing demand for skilled craftsmen, by industry as a whole, which is emphasized in a recently-published government report entitled "Training for Skill," has made it essential for training facilities to be provided, additional to those already offered by the existing schemes of large companies.

At present, the number of men who complete a course of training each year is reckoned to represent 28 per cent of the age group, and in Fig. 1 this percentage is depicted by the horizontal line. In the immediate future, the number of men reaching the age of 21 will increase in accordance with the dotted curve and industry's estimated requirements are shown by the unbroken, upward-sloping curve. Thus, it will be seen that in the year 1967, the demand for trained men is expected to reach some 52 per cent of the much higher number which will then be available.

As long ago as 1953, the Engineering Industries Association formed a sub-committee to examine the problems of apprenticeship training in small firms, with the result that, as reported in MACHINERY, 87/1041—28/10/55, a pilot group training scheme, prepared in collaboration with, and operated by, Industrial Management (R. & A), Ltd., 18 Thurloe Place, London, S.W.7, was put into operation on a small scale in the West London area. This scheme, which has since come to be known as EIAGA, is now well established, and more than 170 firms in various localities participate. The scheme provides for the co-ordination and amalgamation of the resources of firms in groups, with the object of providing thorough training for craft, technician, student, and graduate apprentices. Under the scheme, a boy is apprenticed to one firm but undergoes part of his training with other companies in the group, in order to gain experience in skills not practised by his own organization. His training period follows a carefully planned programme, and is divided into four parts, which are classified as introductory, basic, specialist, and objective.

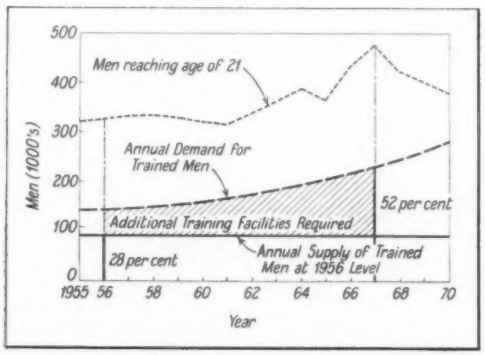


Fig. 1. This Chart Shows the Present Training Rates for Skilled Men, and the Estimated Rates which will be Required in the Near Future

A craft apprentice generally spends the first 18 to 24 months with his parent firm, to receive the introductory and basic training. The object of the course, and the importance of theory are first explained, and the apprentice is next given instruction in bench work; in operations such as drilling, turning, shaping, and milling; and then in inspection procedures. There follows a 2½ year period of intensive specialist training, during which he gains practical knowledge and experience of skills appropriate to his craft. It is at this stage, in instances where facilities called for in the syllabus are not available at the parent works, that the transfers to other firms in the group are effected. During specialist training, the apprentice also gains a knowledge of trades complementary to his own. For the final year—the period of objective training—the apprentice returns to the firm to which he is indentured, and works at his chosen craft.

The content of the course for a turner, for example, normally provides, after the completion of the two years of preliminary work, for the remaining three years to be spent on advanced training on machines such as centre lathes, turret lathes, and boring mills. Instruction in the use of other machine tools is given, and training sessions are arranged in foundries, welding shops and drawing offices, for instance. Among the other skilled occupations covered by E.I.A.G.A. training may be mentioned setter and setter-

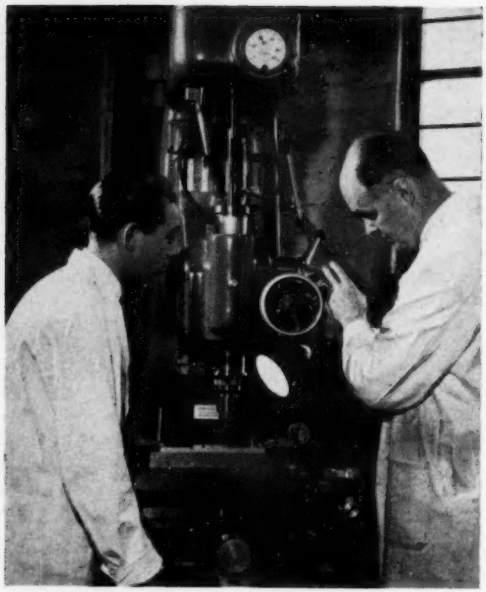


Fig. 2. Apprentice P. E. Mills, Receiving Instruction in Operating a Jig Boring Machine at the Works of Joyco Engineering Co., Ltd., Hillingdon

operator for milling and grinding machines, pattern maker, moulder, welder, sheet-metal worker, boiler maker, tool-maker, fitter, instrument maker, millwright, and electrician.

Fig. 2 shows apprentice P. E. Mills receiving instruction in operating a jig boring machine at the works of Joyco Engineering Co., Ltd., Hillingdon.

Craft apprentices who show suitable aptitude and ability are considered for transfer to technician and student-engineer apprenticeships, and they then receive training to fit them for positions in design, development, and production departments. These apprentices, during their fourth and fifth years of training, are given assignments to develop initiative, in order to ascertain the types of work which they are best suited to undertake.

Candidates for graduate apprenticeship must possess an engineering degree. They follow a 2-year course arranged in accordance with the requirements of the professional institutions, and ultimately qualify for staff appointments with their parent companies.

Prepared with the co-operation of many institutions and associations who have previously issued recommendations for apprenticeship courses, the EIAGA training syllabuses cover the majority of crafts, also all grades of technician, student-engineer and graduate apprenticeships. The craft apprenticeship syllabus is based on that approved by the National Joint Body of the Engineering & Allied Employers National Federation, and the Confederation of Shipbuilding and Engineering Unions, and all syllabuses describe in detail the practical and theoretical instruction which apprentices should receive.

CONSTITUTION AND ADMINISTRATION

Membership of an EIAGA group is open to any firm employing skilled engineers. The local policy of each group of firms is controlled by a committee composed of senior executives from the member companies, and co-opted representatives of youth employment services and educational organizations. Administration is handled by an engineer on the staff of the training division of Industrial Administration (R. & A.), Ltd., who, as executive officer of the committee, acts in the capacity of group apprentice supervisor. He is responsible for the initial selection of boys, preparation of the individual training programmes, co-ordination of training, interchange of apprentices, guidance of the tradesmen who give instruction, and liaison with technical colleges. The apprentice supervisor maintains close contact with the apprentice, and ensures that the training follows the syllabus, also that the boy receives the greatest possible benefit from it. Reports on each boy are regularly prepared and forwarded by the apprentice supervisor to the sponsoring firm, and, in less detail, to the boy's parents. The boy's progress is thus continually reviewed, and, with this system, the training programme can be revised at any time, should events show this to be desirable.

SELECTION OF APPRENTICES

In selecting boys for entry into the scheme, an assessment of character, physique, education, and general suitability is made, before the candidates are submitted to the sponsoring firms. The applicants' parents are interviewed, and the conditions of training and the opportunities available are explained to them. New recruits are regarded as probationers for the first few months, after which their apprenticeships are confirmed and they are indentured to the sponsoring firms. The indenture is signed as soon after an apprentice's sixteenth birthday as possible.

Theoretical background is provided by attend-

ance at approved courses of technical study, and the apprentice is advised concerning the courses for which he should enrol. Before enrolment day, the apprentice supervisor visits the technical college and agrees with the staff the courses for which his candidates will enter. Release from work during the day for attendance at classes is arranged, without loss of pay. On satisfactory completion of their training, apprentices are awarded an EIAGA Certificate of Apprenticeship on which details of their training are endorsed. They are then advised to take examinations appropriate to their chosen trade or profession. For craft apprentices, there are the City & Guilds examinations, while student-engineer apprentices take courses under the National Certificate scheme with the object of qualifying for graduate membership of one of the professional institutions.

Crawford Hydraulic Collet Chuck

The hydraulic collet chuck shown in Fig. 1 has recently been introduced by Crawford Collets, Ltd., Tower Hill, Witney, Oxon. It is intended for use with a range of patent collets of entirely new design, one of which is illustrated in Fig. 2.

Of the dead length type, each collet comprises a number of hardened and ground steel segments, between which spring-steel pieces, of special shape in cross section, are interposed. These parts are retained, to form a single self-contained assembly, by ring-shaped spring clips which are housed in slots near the ends of the segments.

Referring to the diagrammatic, sectional view of the chuck, in Fig. 3, the collet is housed in a taper bore at the nose end of the sleeve *A*, and the latter can slide in a stepped-diameter bore in the body. The collet is located endwise by the internally-threaded nose ring *B*, which surrounds the reduced-diameter right-hand end of the body. An annular space between the sleeve *A* and the body is filled with hydraulic fluid, and communicates with a single cross hole in the body which houses the plunger *C*. Oil seals are fitted at the inner end of the cross hole, and in the body at the ends of the annular space. The plunger *C* is threaded to take a screw, which has a square-section socket at its outer end to receive a chuck key, and can rotate freely in a plug fitted in the cross hole.

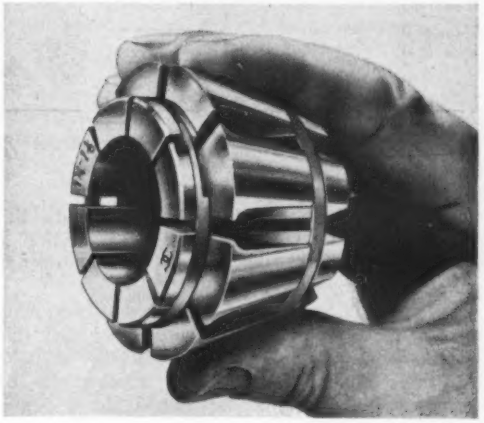


Fig. 2. One of the Collets for Use with the Chuck Shown in Fig. 1

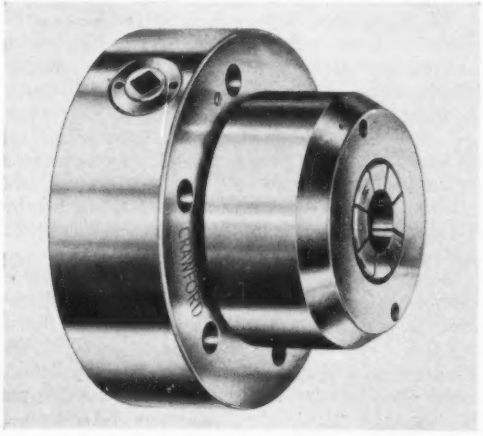


Fig. 1. Crawford Hydraulic Collet Chuck

Movement of the plunger towards the centre line of the chuck, by means of the key, causes the hydraulic fluid to be displaced, with the result that the sleeve *A* is moved to the right. In consequence, the collet is closed by the action between the tapered contact surfaces. An annular steel plate, which is not shown, is attached to the left-hand end of the sleeve *A*, and is engaged by a number of compression springs housed in holes in the body. These springs cause the sleeve *A* to slide to the left, when the plunger *C* is moved outwards by means of the chuck key, and the collet is then opened by the action of the spring-

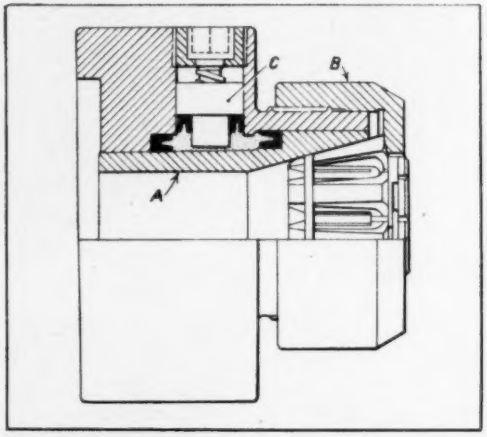


Fig. 3. Sectional View of the Crawford Collet Chuck

steel pieces between the segments. With this arrangement only low torque need be applied to the chuck key in order to exert a very high gripping pressure on the work.

Referring again to Fig. 2, the radial movement of the segments is such that workpieces with diameter variations of as much as ⅛ in. can be held, to a high degree of accuracy for concentricity, by a single collet. Another feature of the design is that a uniform gripping pressure is applied to the work for the entire length of the segments. Since there are no sliding parts, the risk of clogging is reduced when heavily-corroded bar stock is being handled, and the collet can be readily cleaned by rinsing in paraffin.

The chuck is made in three sizes, which are supplied with 7 collets for gripping all diameters from ⅛ to 1 in., 10 collets for diameters from ¼ to 1½ in., and 14 collets for diameters from ⅛ to 2 in. Collets are also available for gripping hexagon and square sections. A patent adjustable back stop can be provided for use with the chuck when short pieces are to be held.

Exhibition of Arc Welding Equipment

The Midlands Electricity Board, in conjunction with English Electric Co., Ltd., will stage an exhibition of arc welding equipment at their industrial showroom, 247 Chester Street, Birmingham 6, from March 24 to April 3. On March 26 and April 2, the exhibition will be open from 10 a.m. to 7 p.m., and the opening and closing times on other days will be 10 a.m. and 4.30 p.m.

Single- and multi-operator arc welding sets with ratings from 200 to 600 amp., which will be on view, have built-in power factor correction condensers. A new rectifier to be demonstrated has a range of 25 to 350 amp., and incorporates a magnetic amplifier which provides for stepless variation of the welding current without the need for moving parts in the transformer.

A wide range of electrodes for the welding of mild and alloy steels will also be exhibited. These items include the recently-introduced Vohees electrodes for vertical and overhead welding of mild steel, and the new Pyristees range of electrodes for use on creep-resisting steels. Mention may also be made of Speedees and Hermees iron powder electrodes which are claimed to permit exceptionally high rates of deposition, and enable the touch welding technique to be employed with consequent improvement in finish. The Groovees electrodes to be displayed have been developed for rapid gouging and grooving of most metals, and may be used, for example, in connection with the reclamation of castings, and for piercing metal plates up to ⅝ in. thick.

Letters to the Editor

[The Editor does not hold himself responsible for the views expressed by his correspondents.]

Millionth of an Inch

[To the Editor of MACHINERY]

SIR,—I was pleased to learn from Mr. Alan Browne's letter, which you published a few weeks ago, that he welcomes the proposal to use the term micro-inch, though he dislikes the abbreviation μin. He proposes instead m″.

His suggestion, however, is unsatisfactory for several reasons. In the first place, the recommended symbol for inch is in. (B.S. 1991: Part I: 1954, p. 33), whereas ″ is the symbol for second in angular measurement (loc. cit., p. 30); again, m is the symbol for metre (loc. cit., p. 30). Mr. Browne's statement that B.S. 1957:1953 advocates 0·000 01″ and 0·000 001″ is misleading: this standard certainly advocates the spacing of the noughts, but Mr. Browne has unwittingly added ″ to the examples quoted.

On the question of the use of Greek letters as symbols, international co-operation between scientists and engineers makes it essential that a common vocabulary of symbols is used. The International Organization for Standardization covers the English units as well as the metric—see, for example, ISO Recommendation R31, Part 1, p. 7—and we should get nowhere if we attempted to introduce the symbol m when the widely

recognized symbol μ is already available. The British electrical engineer has, of course, used μ (in μF, the microfarad) for very many decades. We may not like the Greek alphabet, and at the moment we may have to improvise on the typewriter, but these are things we must discount for the common good.

J. C. EVANS,
Metrology Division, National Physical Laboratory.

Teddington

N.R.D.C. Report on Inventions

Established by the Board of Trade under the Development of Inventions Act, 1948, to secure, where it is in the public interest, the development or exploitation of inventions, the National Research Development Corporation, 1 Tilney Street, London, W.1, has recently published its eighth report.*

Commenting on projects already mentioned in previous years, the report deals with progress in the field of electronic digital computers, and gives information on research carried out on new data processing systems. It is stated that work is more than half completed on the development of a business-type computer and data processing system, which makes use of magnetic cores and transistors and has extensive input, output, and storage facilities. Another project is concerned with an electronic data processing system for production planning, and engineering stores inventory, which is being developed in collaboration with Siemens Edison-Swan, Ltd., a member of the A.E.I. group. Application of the system in the firm's telephone plant at Woolwich is expected in the immediate future.

Certain exploratory work has been started in connection with computers, which would have operating speeds several hundred times as great as are obtainable with those at present available, for performing, to greater accuracy, calculations connected with nuclear reactor design, for example. The construction of these computers will depend upon the development of components now only in the research stage, such as "fast" transistors. In this connection it has been recently stated by a member of the Corporation, that if such research is not actively pursued the computer industry in this country will tend to lag further behind that of the U.S.A.

The report gives further information on a regenerative mechanical power transmission system invented by Mr. R. C. Clerk, for storing, in a flywheel, energy which is otherwise dissipated when brakes are applied. The energy thus stored is then available for purposes of acceleration. Design of a prototype, for installation in a Midland Red public service vehicle, is well advanced, and it is hoped that the unit, which incorporates a 2-ft. diameter flywheel weighing about 210 lb., will be in service this year. With this equipment a considerable saving in fuel costs is expected to be obtained.

Fundamental research and development work continues at the Manchester College of Science and Technology on the solution of problems arising in the design of machine tools which are to be controlled directly by electronic computers.

Among new projects sponsored by the Corporation may be mentioned an invention by Dr. A. R. Burkin of the Imperial College of Science and Technology for the extraction of ores of special metals by unconventional methods of leaching; the Fletcher technique whereby certain metals may be extracted from the vapour phases of the metal halides by decomposition in a high vacuum; and a four-high rolling mill, developed by Mr. G. W. Lord of the G.P.O. research station at Dollis Hill, for rolling thin strip in a few passes to thicknesses down to 0·0001 in. The mill has now been completed and installed at the works of Henry Wiggin & Co., Ltd., where it will shortly be demonstrated.

* National Research Development Corporation. Report and Statement of Accounts for the year ended June 30, 1957. House of Commons Paper 99. H.M. Stationery Office. Price 2s. 0d. net.

U.S. Machine Tool Exports

The following table gives the quantities and value of exports of various classes of machine tools from U.S.A. during June, 1957.

	Number	Value $
Engine and tool room lathes	114	294,563
Light duty and bench lathes	222	43,151
Turret lathes	15	171,681
Other lathes	55	1,173,854
Vertical boring and turning mills	9	310,399
Boring machines	41	1,115,118
Tapping and threading machines	104	168,170
Milling machines	98	1,547,777
Gear cutting machines	22	451,846
Gear grinding and finishing machines	11	158,714
Drilling machines	216	546,549
Planing, shaping and slotting machines	18	37,825
Surface grinding machines	67	333,806
Tool and cutter grinding machines	57	180,444
Other grinding machines	57	1,777,724
Honing and lapping machines	88	193,606
Broaching machines	6	108,266
Sheet and plate metal-working machines	383	3,632,572
Forging machines and hammers	45	1,471,649
Metal forming machines	—	699,408
Other machines	1,207	1,045,402

News of the Industry

Yorkshire

DEAN, SMITH & GRACE, LTD., Keighley, are busy with the production of standard centre lathes ranging from 13 to 30 in. swing, surfacing and boring lathes from 13 to 24 in. swing, and 17-in. swing toolroom lathes with built-in relieving equipment.

Numerous interesting features have been incorporated in the latest design of 13-in. swing lathe, including spindle reverse by multi-plate friction clutches operated from the apron, provision for coarse pitch screwcutting up to 2 in. maximum lead, and enclosure of the driving motor in the base to reduce the floor space occupied. Hydraulic copying attachments are being applied to standard lathes of 13, 17 and 21 in. swing, and the arrangement is such that the front tool-slides can be used for normal turning and screwcutting operations. All the controls are within easy reach of the operator, and micrometer longitudinal and in-feed adjustment for the copying tool enables setting-up time to be reduced. A tie bar connecting the copy centres facilitates positioning of the master in relation to the workpiece. We hope shortly to describe the copying equipment more fully. Export orders are being received from many countries including Australia, Canada, New Zealand, South Africa, and the Rhodesias.

WARD, HAGGAS & SMITH, LTD., Keighley, are mainly occupied with the building of lathes and planing machines. Among the former may be noted 6½-in. centre machines and a 60-in. swing surfacing and boring lathe, while the latter include a 12- by 4-ft. square double-standard machine, an 8- by 3-ft. square openside type for Trinidad, and a 6-ft. by 30-in. square planer for Ceylon. A motor-driven rail planing machine, with two toolboxes, has recently been completed for the Nigerian Railways, and we hope to refer again to this machine in due course.

D. MITCHELL & CO., LTD., Keighley, report a steady demand for 8½- and 12½-in. centre lathes, with beds of various lengths, for customers both at home and abroad. The latest addition to plant at these works is a Ward No. 7 combination turret lathe. At the associated DARLING & SELLERS works, lathes are in progress of 10½-, 14½- and 16½-in. centres, and we may note that an Ormerod 26-in. stroke, single traversing head, shaping machine has recently been installed. In the same group, N. HARGREAVES & CO. are building 6½-in. centre lathes, with beds 6, 7 and 8 ft. long, many of which are destined for overseas customers. The principal export markets are Australia, New Zealand, and Rhodesia.

KEIGHLEY GRINDERS (MACHINE TOOLS), LTD., have a good order book for both standard and special plain, universal, angle-head, and internal cylindrical grinding machines, including the automatic internal type. In the works, our attention was drawn to a recently-developed gauge grinding machine, which is equipped with a 2-stage sizing attachment, enabling work to be finished to 1 micro-inch or better, on a production basis. We hope to describe this machine more fully in a later issue. Another interesting machine noted is for grinding refrigerator rotors with a large-diameter abrasive wheel, and arranged for lever-operation from the rear. An intermediate size of plain grinding machine, in course of development, will swing 6 in. diameter. Overseas destinations for the firm's products include Australia, Canada, India, France and Spain. A new bay has recently been added to provide increased erecting shop space, and the latest additions to the plant are a Newall jig boring machine with milling feeds, an Asquith 5-ft. O.D.1 radial drilling machine, and a Herbert No. 7 combination turret lathe.

A. FIELDING & CO. (KEIGHLEY), LTD., Keighley, are steadily employed on the production of 16- and 18-in. swing centre lathes, some of which are destined for South Africa, New Zealand and Canada. Other work includes a variety of milling and boring heads and various special equipment. A bar reeling and straightening machine for steel rolling mills, which is now being developed, will have a capacity for work from ¼ to 2 in. diameter.

VERNIERS (KEIGHLEY), LTD., Bradford Road, Keighley, are experiencing a steady call for precision instruments, which include vernier calipers, height gauges, and combined dial indicator stands and scribing blocks, in a range of sizes. Plug, plate, gap, and built-up type gauges for inspection and production purposes are also in evidence, together with drill jigs, and milling, assembly, and inspection fixtures. In addition, repair work is carried out on all types of gauges and vernier calipers. Another of the firm's activities is the manufacture of special milling cutters, reamers, and drills.

DAVID BROWN INDUSTRIES, LTD., Automobile Gearbox Division, Huddersfield, have recently

booked an order, from one of the leading motor vehicle manufacturers, for 500 gearboxes. The gearbox ordered is a 4-speed unit, designed for a maximum torque of 166 lb.-ft. Constant-mesh gearing is employed, but provision has been made for the introduction of synchromesh gearing if required. In connection with this order, prototype gearboxes were designed and built in 12 weeks, and subsequently successfully tested. Quantity production is to start at the Huddersfield works in April.

H. B.

London and the South

ABBEY HEAT TREATMENTS, LTD., High Street, Merton, London, S.W.19, continue to be very busy with work both for local firms and for others in distant parts of the country. In recent years this firm has steadily increased its capacity for undertaking all types of heat treatment, and we are informed that an associated company, Abbey (Precision) Heat Treatments, Ltd., Kenthouse Lane, Beckenham, Kent., has also installed extra equipment, including a 20-kW. Redifon induction heating plant. At the works at Merton there is a plant for applying a black protective finish to metal parts. The process, which involves dipping and rinsing operations in several baths, is completed in a short time cycle.

CORFIELD & BUCKLE, LTD., Trafalgar Works, Merton Abbey, London, S.W.19, are actively engaged in the production of pressings and machined sub-assemblies, on a contract basis, for a wide range of domestic appliances. Press work requiring forces up to 150 tons, in most metals, can be produced here, and it may be noted that artificial limbs figure regularly among this firm's products. The manufacture of limbs is carried out by deep drawing followed by spinning operations before final shaping to individual requirements. The company's range of presses is comprehensive and includes four machines by Cowlishaw, Walker & Co., Ltd.

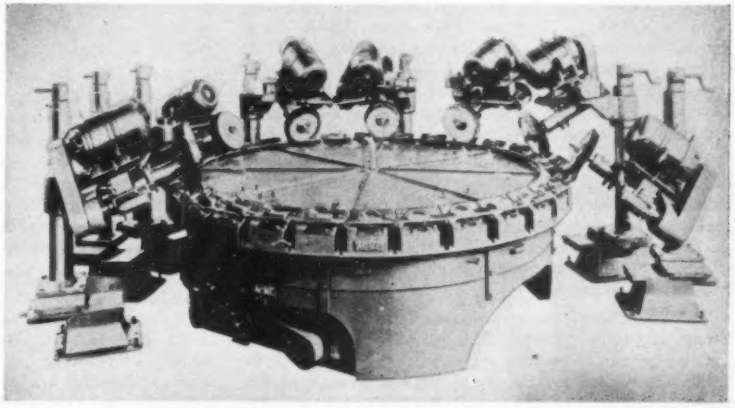
COOPER - STEWART ENGINEERING CO., LTD., Works Road, Letchworth, Herts., continue to receive numerous enquiries for their extensive range of low pressure, rotary vane type, air compressors and exhausters which have a diversity of industrial applications. This company has supplied many vacuum-brake testing units, which are used by railway engineers for checking the effectiveness of brakes fitted to rolling stock.

The normal range of air compressors covers delivery capacities from 6 to 300 cu. ft. per min. at pressures from 3½ up to 60 lb. per sq. in., with either air or water cooling. Exhausters giving continuous vacua down to 20 in. of mercury with air cooling, or 28 in. of mercury with water cooling, are also in production. During recent years this company has developed a type of exhauster and compressor which does not require oil lubrication. It is hoped to start production of this new series in the near future.

F. W. H.

Acme Automatic Polishing Machines

Electro-Chemical Engineering Co., Ltd., Sheerwater, Woking, Surrey, have been appointed sole sales representatives in Great Britain for all products of Acme Mfg. Co., Detroit, U.S.A. They inform us that Acme automatic and semi-automatic polishing machines are now being made for the European and other non-dollar markets in a new factory at Neu-Isenburg, near Frankfurt-am-Main, Western Germany, and stocks of essential spares will be held in this country. An Acme continuous rotary automatic polishing machine with an 8-ft. diameter table and eight polishing heads is shown in the figure.



Acme Continuous Rotary Automatic Polishing Machine

Industrial Notes

MARTONAIR, LTD., have opened a new branch office at 71 Carver Street, Sheffield, 1 (telephone number, 21641). Stocks of pneumatic cylinders, valves, and accessories will be carried.

SUTOR ENGINEERING, LTD., is the new title under which the Engineering Division of Lotus, Ltd., is now operating. The new company remains part of the Lotus organization, and the address is Sandon Road, Stafford.

SIR W. H. BAILEY & CO., LTD., Patricroft, Manchester, have been appointed sole distributors for flow-indicating equipment produced by Dukes & Briggs Engineering Co. To supplement the available Telicator visual flow-indicators, production of other types will begin shortly.

SEMICONDUCTORS, LTD., inform us that, following the arrival and installation of the transistor production equipment, their sales and administrative staffs have moved from Ilford to the new factory at Cheney Manor, Swindon, Wilts. (telephone number, Swindon 6421-2).

METROPOLITAN-VICKERS ELECTRICAL CO., LTD., inform us that from March 24 the postal address of their Sheffield district office will be 9 Market Place, Sheffield, 1. The telephone numbers (Sheffield 23114/5/6/7 and 27848) will not be changed.

AN AUCTION SALE OF MACHINE TOOLS and miscellaneous stores from M.O.S. Sub-depot, Lily Lane, Byley, Middlewich, Cheshire, will be held on April 1 and 2 at New Islington Public Halls, Ancoats, Manchester. The auctioneers will be J. H. Norris & Son (Dept. N), 9 Albert Square, Manchester, 2.

PRODUCTION OF IRON CASTINGS in the fourth quarter of 1957 amounted to 962,050 tons, compared with 973,510 tons in the corresponding quarter of 1956, according to a statement issued by the Iron and Steel Board. Output for the year 1957 totalled 3,715,100 tons, as against 3,899,170 tons in 1956.

FIRTH CLEVELAND INSTRUMENTS, LTD.—A new factory is to be erected at Treforest, Glamorgan, South Wales, for this company, which was formed last May as a subsidiary of Simmonds Aerocessories, Ltd. Measuring approximately 350 ft. long by 240 ft. wide, this factory will have an area of about 80,000 sq. ft., with first floor office accommodation on two sides.

LANG-LONDON, LTD., inform us that their premises at 45 Hampstead Road, London, N.W.1, have been considerably extended, and from March 24 all office departments will be accommodated at this address, where adequate parking facilities are available. The telephone number (Euston 3744—2 lines) and telegraphic address (Centrilang) have not been changed.

THE SCHOOL OF TIME AND MOTION STUDY, LTD., 29 Cork Street, Piccadilly, London, W.1, is making arrangements, for the benefit of smaller firms, for experts to visit the principal industrial areas this year and stage week-end appreciation courses for management, based on films, lectures, and case histories. The tour will start in Scotland on September 1.

COIL SPRING FEDERATION RESEARCH ORGANIZATION, P.O. Box 121, 301 Glossop Road, Sheffield, 10, announce that their Annual conference will be held at the Imperial Hotel, Torquay, from June 5 to 8. The business meetings will be on the morning of June 6, and there will be a technical session on the morning of June 7. Social activities are being arranged for the week-end.

JOHN S. YOUNG & CO., LTD., Maryville Avenue, Giffnock, Glasgow, have arranged for working demonstrations of the full range of Colchester lathes, also the new Colchester copying equipment, from Monday to Friday, March 17 to 21, from 10 a.m. to 5 p.m. In addition there will be demonstrations on the evenings of March 18 and 19, until 9 p.m.

THE PLESSEY CO., LTD., recently announced that a separate bay of one of their Swindon factories had been equipped for use as an apprentice training school. A wide range of machine tools and equipment is here installed, and first-year boys will receive thorough instruction under the supervision of Mr. A. A. Steele. At present, 68 apprentices are employed at the Swindon factories of the company, and the number is to be increased to approximately 90 next August.

THE HYMATIC ENGINEERING CO., LTD., Redditch, Worcs., inform us that their Hydrovane mobile compressor, type 98P100, which was originally designed for export only, is now in full production, and is available to the home market, where it will replace the type 60P100. This new compressor has a free air delivery of 72 cu. ft. per min. and is suitable for operating such tools as impact wrenches and riveting hammers at pressures up to 100 lb. per sq. in.

THE FIRST CHEMICAL AND PETROLEUM ENGINEERING EXHIBITION, sponsored by the British Chemical Plant Manufacturers' Association and the Council of British Manufacturers of Petroleum Equipment, and organized by F. W. Bridges & Sons, Ltd., Grand Buildings, Trafalgar Square, London, W.C.2, will be held at Olympia from June 18 to 28. Some 250 exhibitor manufacturers have booked space totalling 125,000 sq. ft., and the display will occupy the two largest halls and galleries.

THE UNITED STEEL COMPANIES, LTD., have decided to set up a central drawing office in London and are equipping premises at 125-127 Victoria Street, S.W.1, for this purpose. It is anticipated that between 20 and 30 draughtsmen will be employed initially. The new office will provide facilities for design work on development projects, and for detailed drawings of plant and engineering work required by the company's branches, to supplement the activities of their individual drawing offices.

THE ENGINEERING METROLOGY ASSOCIATION, Northampton College, London, E.C.1, have issued a booklet entitled "the first six years," with a foreword by the president, Mr. F. H. Rolt, O.B.E., D.Sc. The circumstances which led to the formation of the Association are outlined, and a chart is included indicating the range of metrology. In addition there are notes covering the first 50 ordinary meetings, with titles of lectures, names of lecturers, and brief summaries of contents.

B.T.R. INDUSTRIES, LTD., Herga House, Vincent Square, London, S.W.1, have concluded a licensing agreement with TUBE TURNS PLASTICS, INC., Louisville, Kentucky, U.S.A., whereby they will manufacture in Great Britain unplasticized polyvinyl chloride pipe fittings, valves, and special moulded parts by the Hendry process. Components made by this process, which is covered by British patents, are said to possess complete homogeneity, high density, dimensional accuracy, and high strength.

B.P.C. FILM CATALOGUE.—The British Productivity Council, 21 Tothill Street, London, S.W.1, have issued a new catalogue of films, with descriptive notes. Copies of these films can be purchased from the above address, or hired from the Central Film Library, Government Building, Bromyard Avenue, Acton, London, W.3. In this connection the Council point out that the film has been found to be one of the best media for "putting across" both the need for raising productivity and practical appreciation of new techniques and methods for increasing output.

BRITISH RUBBER DIRECTORY.—The 1958 edition of the Directory of British Rubber Manufacturers and Products provides a complete buyers' guide to the British rubber industry in English, French, German and Spanish. It is published by the Federation of British Rubber and Allied Manufacturers, 43 Bedford Square, London, W.C.1, and is free to overseas importers of rubber products, being primarily intended for circulation abroad. A limited number of copies will be available to others (price 25s., post free 28s.) and application should be made to the above address.

W. E. SYKES, LTD., of Manor Works, Staines, Middlesex, are staging a window dislay at the Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, until March 31. The Sykomatic magazine loading gear generator will be the main theme of this display. Typical gears produced by the machine will be shown, together with a double helical gear and a sectioned motor vehicle gear box, for which all the gears were produced by Sykes generators. In the Centre itself, a range of Sykes spur and helical gear cutters, hobs, and shaving tools is on view.

WILLIAM JESSOP & SONS, LTD., Brightside Works, Sheffield, 6, announce that, to enable engineers and designers to examine for themselves the properties of titanium in connection with new projects, they are prepared to co-operate by offering development supplies of Hylite titanium on "specially attractive terms," and will supply information on titanium and its applications, on request. We understand that the range of Hylite alloys can now be supplied as billets, forgings, drop stampings, bar, rod, and wire. Certain grades are also available in the forms of sheet, strip, tube, and extruded sections.

THE WILMOT BREEDEN GROUP of companies, Amington Road, Birmingham, 25, are sponsoring two fellowships, each valued at £1,000 per annum, one at the University of Birmingham and the other at the College of Technology. An unusual feature of these fellowships is that the successful candidates will divide their time between the university or college and the company. The fellowships will be advertised every year in March, in "odd" years in association with the university and in "even" years in association with the college. Each fellowship will normally be held for a period of two years.

THE CENTRAL ELECTRICITY GENERATING BOARD has recently placed orders for two 275,000-kW. steam-turbo-alternator sets, with condensing and feed water heating plant, valued at more than £5,000,000, with the English Electric Co., Ltd., Marconi House, Strand, London, W.C.2, and for two 275,000-kW. boilers with Yarrow & Co., Ltd., Glasgow. This plant is required for the proposed Blyth "B" power station in Northumberland, and it is stated that the in-line turbo-alternators will be the largest of their kind in the world. Each set will comprise a 3-cylinder 3,000-r.p.m. re-heat turbine with quadruple exhaust, arranged as a tandem compound unit, which will be coupled to a direct hydrogen-cooled alternator.

WILD-BARFIELD ELECTRIC FURNACES, LTD., Elecfurn Works, Otterspool Way, Watford By-Pass, Watford, Herts., report that their Vacuum Division is making very satisfactory progress. A considerable number of vacuum furnaces is in hand, including what is stated to be the largest induction-heated equipment in the country, and other units for melting and casting beryllium and uranium. In addition, numerous orders are in hand for vacuum gas analysis equipment. This equipment, and the furnaces, are being made, under agreement, to the designs of National Research Corporation, U.S.A. A new designs and production department for vacuum equipment, which has been established by Wild-Barfield, is operating in close liaison with the corresponding department of N.R.C.

The Price of a Subscription to MACHINERY is 52 Shillings per annum, post free, to any part of the world.

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14/3/58

Personal

MR. M. C. HARRISON and MR. P. TRUSCOTT have been appointed by The Steel Company of Wales, Ltd., manager and assistant manager, respectively, of the new Bessemer steel plant which is now under construction at Abbey Works, Port Talbot.

MR. L. S. FLATMAN, C.B.E., A.M.I.Mech.E., has been appointed to the board of Dowty Hydraulic Units, Ltd., Ashchurch, Gloucestershire, as production director. Mr. Flatman was formerly Director of Ordnance Factories, Ministry of Supply, and until he resigned was a member of two N.A.T.O. Technical Committees.

MR. FRANK W. RUTTER has joined the technical staff of Tarex (England), Ltd., 22 Buckingham Gate, London, S.W.1, as sales representative for the Midlands and the North of England. For the past eight years Mr. Rutter has been a representative in the Midlands and the West of England for leading agents for Continental machine tools.

MR. D. A. HUBBARD has been appointed a director of Aero Research, Ltd., Duxford, Cambridge. He joined the company in 1939 and shortly afterwards took charge of production. In 1947, he was appointed works manager, with special responsibility for planning and commissioning the large-scale production plants which have been provided at Duxford since that time.

Coming Events

THE INSTITUTE OF METAL FINISHING. *Organic Finishing Group.* March 19 at 6.30 p.m., at the Exchange and Engineering Centre, Stephenson Place, Birmingham; paper on "The Production and Applications of Pre-Painted Strip," by G. E. Burbage.

INSTITUTION OF ELECTRICAL ENGINEERS. *Western Utilization Group.* March 24, at 6 p.m., at Bath Technical College; talk on "Brushless Variable-speed Induction Motors" by Prof. F. C. Williams, D.Sc., D.Phil., and E. R. Laithwaite, M.Sc.

INSTITUTION OF PRODUCTION ENGINEERS. *Midlands Region.* March 24, at 7 p.m., at Sibree Hall, Coventry; "Ceramic Tools," a report by Mr. H. Eckersley on his experiments into the application of ceramics as metal cutting tools. *Norwich Section.* March 19, at 8 p.m., at the Assembly House (Sexton Room), Theatre Street, Norwich; lecture on "Automation of Copy Turning and Its Development." A colour and sound film will be shown. *Birmingham Section.* March 19, at 7 p.m., at the James Watt Memorial Institute, Great Charles Street, Birmingham; joint paper on plastics: "The Replacement of Metal by Laminated Plastics," by G. C. Hulbert, and "The Purpose and Use of Plastic Tooling in Industry," by P. G. Pentz, B.Sc. *Wolverhampton Graduate Section.* March 19, at 7.30 p.m., at the Wolverhampton and Staffs. College of Technology, Wulfruna Street, Wolverhampton; lecture on "Lock Design and Manufacture," by C. G. Smith. *Glasgow Section.* March 24, at 7.30 p.m., at the St. Enoch Hotel, Glasgow; lecture on "Radio Isotopes," by Dr. H. Seligman, Ph.D. *London Section.* March 20, at 7 p.m., at the Royal Empire Society, Northumberland Avenue, Strand, W.C.2; lecture on "Incentive for Indirect Workers," by F. Locke. *Southampton Section.* March 20, at 7.15 p.m., at the Polygon Hotel, Southampton; lecture on "Piston Rings and Liners," by Mr. Bowler.

ROYAL STATISTICAL SOCIETY.—March 19, at 5.15 p.m., at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1; paper on "Industrial Production and Steel Consumption," by Sir Robert Shone, and H. R. Fisher.

INSTITUTION OF MECHANICAL ENGINEERS. *Midland Branch.* March 20, at 6 p.m., at the James Watt Memorial Institute, Great Charles Street, Birmingham; paper on "The Economics of Plant Renewal and Replacement," by C. W. Griffiths.

Open Days at M.E.R.L.

The Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, is to hold Open Days on June 4 and 5. Representatives of any organization with engineering interests will be welcome. Applications for invitations, stating which day is preferred, should be sent to the Director. The whole of M.E.R.L. will be open for inspection, including two new laboratories for research on mechanisms and engineering metrology, and for research on heat transfer.

Obituary

MR. H. H. CLAYTON, home service manager of F. Perkins, Ltd., Peterborough, and manager of the company's engine rebuild department, has died at the age of 61. He joined the company in 1944 as supply manager, and was previously with Ford Motor Co., Ltd., from 1923 to 1944.

Recruitment of Science and Technology Teachers

(*Continued from page* 583)

scientists and technologists are not due to accident or a bit of luck." He emphasized that they were the result of planned policy over the past 25 years. For instance, in Russia the professors and teachers in the technical colleges were among the highest paid people. Their salaries were higher than those of leaders of industry, and their social standing was on the highest level.

Although it is undesirable that we should attempt to emulate all Russian policies, it does seem that in this respect they have given us a lead which we should be well advised to follow. The best in any field is not cheap, and if we are to persuade more of our most promising young men and women to embark on careers in science and technology—as indeed we must—we should not count the cost of ensuring that they have the best tutors that can be provided.

Trade Publications

FRANK WHITELEGG, LTD., 304 High Street, Sutton, Surrey. Leaflets on the following machines made by Th. Calow & Co., for whom they are sole British representatives: type DMR1 centreless bar peeling machine for diameters from 15 to 50 mm.; type DMA4 automatic centreless peeling machine for use with tungsten carbide tools on bars from 30 to 100 mm. diameter; and type DMR5 peeling machine, with high speed steel tools, for bars from 50 to 150 mm.

NEWAGE (MANCHESTER), LTD., 6 Carlos Place, Grosvenor Square, London, W.1. Attractively illustrated brochure describing the company's activities which are concerned with the conversion of motor vehicle engines for industrial purposes. Following a short history of the business, sections are included under the headings: what Newage does to an engine; the range of engines; engine test department; service and spares; and products in the field. It may be noted that the Newage-B.M.C. engines include petrol and vaporizing oil types from 950 to 4,000 c.c., and diesels from 2·2 to 5·1 litres.

Machine Tool Share Market

Stock markets were generally cheerful last week. Prices advanced steadily in most sections, and there was some expansion in the volume of business. The outstanding feature was the upward movement in commercial and industrial shares. High grade issues took the lead, and many substantial gains were shown on balance.

Sentiment was helped by the sharp rise in the gold and dollar reserve figure, and was also assisted by announcements of some good company results, and a number of other favourable factors.

In the gilt-edged section there was moderate but sustained investment support, and quotations of British Funds and similar stocks steadily appreciated, but final prices were slightly below the best.

Among machine tool issues, Edgar Allen advanced 1s. 3d. to 28s.; British Oxygen, 2s. 6d. to 31s. 6d.; Geo. Cohen, 3d. to 11s.; Coventry Machine Tool, 3d. to 9s.; Alfred Herbert, 2s. 6d. to 65s.; and Thos. W. Ward, 1s. 6d. to 73s. 6d. On the other hand, Birmingham Small Arms lost 6d. at 24s. 6d.; Coventry Gauge & Tool, 1s. at 13s.; John Harper, 1½d. at 13s. 10½d.; and Kayser Ellison, 1s. 6d. at 51s. 6d.

THOS. W. WARD, LTD.—Interim dividend 5 per cent (same).

COMPANY		Denom.	Middle Price
Abwood Machine Tools, Ltd.	Ord.	1/-	9d.
Armstrong, Stevens & Son, Ltd.	Ord.	5/-	7/9
Allen (Edgar) & Co., Ltd.	Ord.	£1	28/-
" " "	5% Prf.	£1	14/9*
Arnott & Harrison, Ltd.	Ord.	4/-	14/-
Asquith Machine Tool Corp., Ltd.	Ord.	5/-	18/9xd
" " "	6% Cum. Prf.	£1	17/9
Birmingham Small Arms Co., Ltd.	Ord.	£1	24/6
" " "	5% Cum. "A" Prf.	£1	15/-
" " "	6% Cum. "B" Prf.	£1	17/6
" " "	4% 1st. Mort. Deb.	Stk.	85/-
British Oxygen Co., Ltd.	Ord.	£1	31/6xd
" " "	6½% Cum. Prf.	£1	21/6
Brooke Tool Manufacturing Co., Ltd.	Ord.	5/-	5/6
Broom & Wade, Ltd.	Ord.	5/-	9/9
" "	6% Cum. Prf.	£1	17/9
Brown (David) Corporation, Ltd.	5½% Cum. Prf.	£1	14/4½
Buck & Hickman, Ltd.	6% Cum. Prf.	£1	17/6
Butler Machine Tool Co., Ltd.	Ord.	5/-	6/3
" " "	5% Cum. Prf.	£1	13/9
C.V.A. Jigs, Moulds & Tools, Ltd.	5½% Red. Cum. Prf.	£1	13/9
Churchill (Charles) & Co., Ltd.	Ord.	2/-	4/6
" " "	6% Cum. Prf.	£1	26/3†
Churchill Machine Tool Co., Ltd.	Ord.	5/-	17/6
" " "	6% Cum. Prf.	£1	18/9
Clarkson (Engrs.), Ltd.	Ord.	5/-	10/-
Cohen (George), Son & Co., Ltd.	Ord.	5/-	11/-
" " "	4½% Cum. Prf.	£1	14/6
Coventry Gauge & Tool Co., Ltd.	Ord.	10/-	13/-
" " "	5% Cum. Red. Prf.	£1	16/3
Coventry Machine Tool Works, Ltd.	Ord.	4/-	9/-
Craven Bros. (Manchester), Ltd.	Ord.	5/-	6/-
Elliott (B.) & Co., Ltd.	Ord.	1/-	3/-
" "	4½% Red. Cum. Prf.	£1	13/9
Export Tool & Case Hardening Co., Ltd.	Ord.	2/-	1/6
Firth Brown Tools, Ltd.	4% Cum. Prf.	£1	12/-
Greenwood & Batley, Ltd.	Ord.	£1	46/10½
Harper (John) & Co., Ltd.	Ord.	5/-	13/10½
" "	4½% Red. Cum. Prf.	£1	12/9
Herbert (Alfred), Ltd.	Ord.	£1	65/-
Holroyd (John) & Co., Ltd.	"A" Ord.	5/-	10/6
" "	"B" Ord.	5/-	9/9
Jones (A. A.) & Shipman, Ltd.	Ord.	5/-	21/3
" " "	7% Cum. Prf.	5/-	5/-
Kayser, Ellison & Co., Ltd.	Ord.	£1	51/6
" " "	6% Cum. Prf.	£1	18/3
Kendall & Gent, Ltd.	Ord.	5/-	7/9
Kerry's (Gt. Britain), Ltd.	Ord.	5/-	5/6
Kitchen & Wade, Ltd.	Ord.	4/-	10/3
Martin Bros. (Machinery), Ltd.	Ord.	2/-	2/4½
Massey, B. & S., Ltd.	Ord.	5/-	7/3
Modern Engineering Machine Tools, Ltd.	Ord.	5/-	10/-
Newall Engineering Co., Ltd.	Ord.	2/-	5/-
Newman Industries, Ltd.	Ord.	2/-	2/9
" "	6% Prf. Ord.	5/-	5/6
Noble & Lund, Ltd.	Ord.	2/-	4/9xd
Osborn (Samuel) & Co., Ltd.	Ord.	5/-	16/3
" " "	5½% Cum. Prf.	£1	25/-
Pratt (F.) & Co., Ltd.	Ord.	5/-	20/-
Scottish Machine Tool Corporation, Ltd.	Ord.	4/-	5/3
Shardlow (Ambrose) & Co., Ltd.	Ord.	£1	33/6
Shaw (John) & Sons, Wolverhampton, Ltd.	Ord.	5/-	11/7½
Sheffield Twist Drill & Steel Co., Ltd.	Ord.	4/-	35/-
" " "	5% Cum. Prf.	£1	15/-
Stedall & Co., Ltd.	Ord.	5/-	4/9
Tap & Die Corporation, Ltd.	Ord.	5/-	7/9
" " "	4½% Deb. 1961-1977	Stk.	82/-
Wadkin, Ltd.	Ord.	10/-	19/6
Ward (Thos. W.), Ltd.	Ord.	£1	73/6
" "	5% Cum. 1st. Prf.	£1	15/6
" "	5% Cum. 2nd Prf.	£1	24/3
Willson Lathes, Ltd.	Ord.	1/-	2/4½

The Middle Prices given in the list are in several cases nominal prices only and not actual dealing prices. Every effort is made to ensure accuracy, but no liability can be accepted for any error. * Sheffield price. † Birmingham price.

PRICES OF MATERIALS

All prices per ton except where otherwise stated.

Pig-Iron

Foundry and Forge	
No. 3, Class 2	
Middlesbrough zone	£21 6 0
Birmingham	£20 18 3
Phos. 0·1 to 0·75%	
Birmingham	£23 17 0
Scottish Foundry	
Grangemouth	£25 3 6
Hæmatite	
English No. 1	
N.E. and N.W. Coast	£25 6 6
Scotland	£25 13 0
Sheffield	£26 15 0
Birmingham	£27 4 0
Welsh	£25 6 6

Steel Products

Medium plates	£46 1 6
Mild steel plates, ordinary*	£42 12 0
Boiler plates*	£45 2 0
†Flat bars 5 in. wide and under †Round bars under 3 in.	£40 8 0
Billets, rolling quality, soft U.T.	£33 1 6

Phosphor Bronze

Ingots (2B8) (A.I.D.) d/d	£230 0 0

Copper

Cash (mean)	£165 7 6
Cold rolled and hot rolled Sheets 4 ft. by 2 ft. by 10 SWG	£228 0 0—£231 5 0
Rods $\frac{3}{16}$ in. to $\frac{3}{4}$ in. diam.	£250 5 0
Tubes, $1\frac{1}{2}$ in. bore by 10 SWG, ton lots, per lb.	2s. $4\frac{1}{2}$d.
Wire rod, black, hot-rolled ($\frac{1}{4}$–$\frac{7}{16}$ in.) English	£178 12 6

Zinc

Refined, minimum 98 per cent. purity, current month (mean)	£63 2 6

Brass

Tubes, solid drawn, per lb.	1s. $4\frac{1}{2}$d.
Strip 63/37, 6 in. by 10 SWG coils, ton lots	£199 15 0—£202 5 0
Rods, $\frac{1}{2}$–3 in. diam. (59 per cent copper)	1s. $7\frac{1}{2}$d.

Yellow Metal

Condenser plates, per ton	£140 0 0
Rods, per lb.	1s. $8\frac{1}{2}$d.

Aluminium

Ingots min. 99·5 per cent Canadian d/d	£197 0 0

Lead

Refined, minimum 99·97 per cent purity, current month (mean)	£74 16 3

Tinplates

‡U.K. Home trade:	
Handmill f.o.t. makers' works	£3 12 $2\frac{1}{2}$
Cold reduced, f.o.t. makers' works	£3 7 $10\frac{1}{2}$
U.K. Export:	
Hot rolled basis, f.o.t. works' port	74s. 0d.—75s. 0d.
Cold reduced basis, f.o.t. works' port	76. 0d.

Gunmetal

Ingots, 85.5.5.5. ex works	£149 0 0

* N.E. Coast, N. Joint Area, Central Scottish Zone.

† U.T. soft basic.

‡ Official maximum price, after allowing for adjustments for increase in price of tin.

MAKERS' PRICES

Hexagon Steel Bars[1]

Sizes in inches from 0·7049 up to 2·21 and 2·41 a/f, ex works basis	£43 4 6
Free cutting black	£47 10 0

Reeled Steel Bars[1]

Single-reeled $1\frac{1}{2}$ in. upwards, f.o.t. works (+ usual extra for sizes)	£43 17 6
Free cutting	£48 2 6

High-Speed Steel

Black random length bar. All prices basic, per lb., subject to extras.

Molybdenum "66"	5s. $10\frac{1}{2}$d.
Molybdenum "46"	5s. $8\frac{1}{2}$d.
14 per cent tungsten	5s. 9d.
16 per cent tungsten	6s. $1\frac{1}{2}$d.
18 per cent tungsten	6s. 4d.
22 per cent tungsten	7s. 5d.
5 per cent cobalt 4·75/5·25 per cent molybdenum + 6·0/6·75 per cent tungsten + 1·75/2·05 per cent vanadium (5-6-2)	9s. 6d. 6s. $0\frac{1}{2}$d.

Precision-ground, High-speed Free-turning Brass Rod[2]

$\frac{3}{8}$-in. dia. ± 0·00025-in. 2-ton lots, per lb. 2s. $2\frac{1}{2}$d.

Grey Iron Rod

Die Cast[3] in random lengths 18 in. to 24 in. rough machined $\frac{1}{16}$-in. above listed size. Extra for definite lengths, for hardenable alloy iron, and for orders of less than £50. Discounts for orders over £150.

	Per cwt. net. Mark I	Mark III
$\frac{1}{4}$ or $\frac{3}{8}$ in.	255s. 6d.	318s. 10d.
1 or $1\frac{1}{4}$ in.	204s. 4d.	251s. 10d.
$1\frac{1}{2}$ to $1\frac{3}{4}$ in.	143s. 0d.	171s. 2d.
$1\frac{3}{4}$ to 2 in.	106s. 2d.	125s. 11d.
$2\frac{1}{8}$ to $3\frac{1}{2}$ in.	91s. 6d.	106s. 4d.
$3\frac{3}{8}$ to 12 in.	86s. 6d.	99s. 2d.

Continuous Cast

10-ft. lengths, centreless machined 1 to 3-in. dia. + 0·010 to 0·020 in., prices as quoted for die cast bar[3]

6-ft. lengths centreless ground + 0·010 in. Extra for hardenable alloy iron[4]	$\frac{3}{4}$ or $\frac{7}{8}$ in.	245s.	4d.
	1 or $1\frac{1}{8}$ in.	196s.	4d.
	$1\frac{1}{4}$ to $1\frac{1}{2}$ in.	137s.	10d.
	$1\frac{5}{8}$ to 2 in.	106s.	2d.
Per cwt. net	$2\frac{1}{8}$ to 3 in.	91s.	6d.

Stellite[5]

Welding Rods plain

$\frac{1}{4}$ in. dia. per lb. 30s. 0d.

Toolbits

$\frac{1}{4}$ in. sq. × 4 in., each 22s. 3d

Precision-ground Mild Steel[2]

1-in. dia. + 0·00025-in. 4-ton lots, per cwt. 121s. 6d.

[1] Colvilles, Ltd., Glasgow, and 17 Grosvenor Street, London, W.1. [2] Pratt, Levick & Co., Ltd., Chester. [3] Sheepbridge Alloy Castings, Ltd., Sutton-in-Ashfield. [4] "Flocast," Harold Andrews Sheepbridge, Ltd., Halesowen. [5] Deloro Stellite, Ltd., Highlands Road, Shirley, Solihull.

BASIC PRICES FROM LONDON STOCK[6]

Free Cutting Steel

Bright cold drawn:	
(Usaspead) over $1\frac{1}{2}$ to 2 in.	£59 17 6
Lead bearing (Usaled)	£63 17 6
Precision ground, $1\frac{3}{4}$ in.	£81 12 6

Bright Drawn

M.S. bars (M.M.C.) over $1\frac{1}{2}$ in. to 2 in.	£55 8 6
Square edge flats (Usaflat)	£72 5 0
M.S. angles (Usaspead)	£99 10 0
Casehardening (EN) (Usacase) over $1\frac{1}{2}$ in. to 2 in.	£63 14 6
M.S. bars (EN3B) (Usamild) over $1\frac{1}{2}$ to 2 in.	£57 8 6
Carbon manganese semi-freecutting case hardening (EN202) (Usaspead 202) over $1\frac{1}{2}$ to 2 in.	£71 14 0
35/45 ton tensile (EN6) (Usen) over 1 to $1\frac{1}{2}$ in.	£65 2 6
0·4 Carbon Normalised (Usaspead "40") over $1\frac{1}{2}$ in. to 2 in.	£67 4 6
Carbon manganese steel to Specification EN.16.T (Usaspead 5565), per ton	£127 10 3

Ground Flat Stock

18-, 24-, and 36-in. lengths (Usaspead). List prices less 5 per cent

Oil Hardening Cast Steel

Non-shrink (Usaspead N.S.O.H.) $\frac{3}{4}$ in. to $2\frac{3}{4}$ in., per lb.	1s. 11d.
Non-distorting heavy duty (Usaspead H.C.H.C.) $\frac{3}{4}$-in. to $2\frac{3}{4}$-in., per lb.	4s. 2d.

Silver Steel

(0·194-in. to $1\frac{1}{2}$-in.)

Genuine Stubs quality, per lb.	4s. 6d. less 27½%
M.M.C. quality, per lb.	2s. 5d. + 6½%
Boxes of 16 assorted sizes $\frac{1}{16}$-in. to $\frac{1}{2}$-in. dia.	7s. 6d.

Stainless Steel

K.E. 40.AM (Freecutting), per lb. 3s. $3\frac{1}{2}$d.

Glacier Machined Bronze Bars

Phosphor bronze (2B8)
Lead bronze — Prices on application

High-speed Steel

18 per cent tungsten. Prices on application.

Toolholder bits:	
Usaspead "Super"	List price
" "Supreme"	
" Cobalt 10	

Shimstock

Steel assorted, per tin	3s. 6d.
Brass " "	7s. 3d.

[6] Macready's Metal Co., Ltd., Pentonville Road, N.1. Subject to confirmation by London Office. Delivered free by van in London area.